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VOLUME 3 NUMBER 3

# Scientific and Technical Aerospace Reports

*A Semimonthly Publication of the National Aeronautics and Space Administration*

*FEBRUARY 8, 1965*

## 01 AERODYNAMICS

Includes aerodynamics of bodies, combinations, internal flow in ducts and turbo machinery; wings, rotors, and control surfaces. For applications see: 02 Aircraft and 31 Space Vehicles. For related information see also: 12 Fluid Mechanics; and 33 Thermodynamics and Combustion.

**N65-12465#** France. Office National d'Etudes et de Recherches Aeronautiques, Chatillon-sous-Bagneux. Section de Recherches

**THE EXPERIMENTAL DETERMINATION OF UNSTEADY HYDRODYNAMIC FORCES CAUSED BY WAVES OF PROPULSION LIQUIDS [LA DETERMINATION EXPERIMENTALE DES FORCES HYDRODYNAMIQUES INSTATIONNAIRES DUES AU CLAPOTIS DES LIQUIDES DE PROPULSION]**

C. Beatrix Paris, NATO, 1964 28 p refs in FRENCH; ENGLISH summary Presented at the Agard Mater. and Struct. Group Meeting, Liege, 27 May–2 Jun. 1964

(Rept.-476)

The generation of unsteady hydrodynamic forces due to the oscillation of the propulsion liquids in containers of missiles may influence their performance in flight. Theory permits only a partial solution to this problem and must be supported by tests. The experimental method devised at the O.N.E.R.A. and the synthesis of the tests carried out for one type of missile are described. Author

**N65-12560#** Aerospace Corp., El Segundo, Calif. Laboratory Operations

**AERODYNAMIC INFLUENCE COEFFICIENTS FOR TWO-DIMENSIONAL, MULTIBAY PANELS AT SUPERSONIC SPEEDS**

M. H. Lock, W. P. Rodden, E. F. Farkas, and H. A. Malcom 15 Oct. 1964 98 p refs

(Contract AF 04(695)-269)

(SSD-TDR-64-186; TDR-269(4230-10)-8; AD-452245)

A method is presented for computing the aerodynamic influence coefficients for multibay, two-dimensional, flat panels at supersonic speeds. The method is based on the linearized theory of inviscid supersonic flow; the development of the aerodynamic influence coefficients (AICs) follows the work of Rodden and Revell. The Aerospace IBM 7090/94 Computer Program No. ES053A provides the AICs in printed and punched-card output formats. The program capacity is one Mach number, 50 values of reduced frequency, 5 panel bays, and a maximum total of 50 control points. The unsteady case option requires 9 control points per bay. Author

**N65-12577#** ARO, Inc., Arnold Air Force Station, Tenn.

**PRESSURE TESTS ON THE STANDARD HYPERVELOCITY BALLISTIC MODEL HB-2 AT MACH 1.5 TO 5**

Jerry H. Jones Arnold Eng. Develop. Center, Nov. 1964 27 p refs

(Contract AF 40(600)-1000)

(AEDC-TDR-64-246; AD-451892)

Data were obtained at Mach 1.5, 3, and 5 at angles-of-attack of 0, 3, 5, 10, and 15 deg, and at Mach 2 and 4 at zero angle-of-attack. Reynolds number, based on the centerbody diameter, ranged from $0.32 \times 10^6$ to $2.32 \times 10^6$. Pressure distributions are presented, and a comparison is made of force and moment coefficients obtained from integrated pressure data with results from previous force tests on this model. Author

**N65-12589#** Naval Ordnance Lab., White Oak, Md.

**WIND TUNNEL MEASUREMENTS OF THE AGARD CALIBRATION MODEL B AT TRANSONIC AND SUPERSONIC SPEEDS**

J. B. Eades, Jr. Nov. 1964 27 p refs *Its* Aerodyn. Res. Rept.-199

(NOLTR-63-84; AD-451011)

Tests were conducted at free-stream Mach numbers ranging from 0.70 to 3.50, at angles-of-attack from $-4°$ to $+10°$, over a Reynolds number range from $0.20 \times 10^6$ to $0.62 \times 10^6$. Author

**N65-12638#** National Physical Lab., Teddington (Gt. Brit.) Aerodynamics Div.

**AN INVESTIGATION OF THE FLOW ABOUT CIRCULAR CYLINDERS PLACED NORMAL TO A LOW-DENSITY, SUPERSONIC STREAM**

S. C. Metcalf, C. J. Berry, and B. M. Davis 8 Apr. 1964 49 p refs

(NPL-AERO-1097; ARC-257931)

The pressure distribution around circular cylinders was measured near $M\infty = 2$ for Reynolds numbers between 5 and 135. The induced pressure, due to viscous effects, was estimated by using a tangent-cylinder method and was found to agree well with the experiment. The pressure drag increased gradually with rarefaction, and the estimated skin-friction drag increased as $1.7/\sqrt{Re_D}$. A diagram of the flow was built up from the pressure measurements, wake traverses, and argon-afterglow photographs. Author

**N65-12643#** Royal Aeronautical Society, London (Gt. Brit.)

**AERODYNAMICS DATA SHEETS**

Aug. 1964 58 p refs

This paper contains a collection of aerodynamic data sheets pertaining to the following subjects: "Normal Shock Waves"; "Wave Drag of Flat Plates with Blunt Noses"; "Flow and Losses in Bends"; "Flow through a Sudden Enlargement in a Pipe"; and "Constrictions (Perforated Plate, Round-Wire Gauzes) in Ducts." G.G.

**N65-12683*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**EXPERIMENTAL INVESTIGATION OF A MACH 5 ISENTROPIC SPIKE INLET AT AND BELOW DESIGN SPEED**
Leonard E. Stitt and Richard J. Flaherty Washington, NASA, Aug. 1959 15 p refs
(NASA-TM-X-4) OTS PRICES: HC $1.00/MF $0.50
(Declassified)

An isentropic spike inlet designed for maximum external compression at Mach 5.0 was investigated over a range of Mach numbers at zero angle-of-attack. At the design point a peak total-pressure recovery of 43% was obtained, compared with a theoretical maximum of 50%. The corresponding cowl-pressure drag coefficient was 0.04, based on maximum cross-sectional area. At Mach numbers lower than 2.5, boundary-layer separation behind the bow shock resulted in low total-pressure recoveries. Also near Mach 2.0, the cowl-plus-additive-drag coefficient was at its maximum, 0.47, based on maximum cross-sectional area. Author

**N65-12684*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**DYNAMIC RESPONSE OF A SUPERSONIC DIFFUSER TO BYPASS AND SPIKE OSCILLATION**
David N. Bowditch and Fred A. Wilcox Washington, NASA, Aug. 1959 32 p refs
(NASA-TM-X-10) OTS Prices: HC $2.00/MF $0.50
(Declassified)

The amplitude and phase shift of static-pressure variations in a supersonic diffuser were investigated for separate oscillation of both the spike and bypass. Dynamic data are presented for the supersonic diffuser in combination with a J34 engine and three cold-pipe configurations of different length at Mach 1.8 and 2.0. Static-pressure variations were measured in the region of the terminal shock, near the bypass ports in the main duct, and near the choke point in the cold pipes. A simple method for predicting the dynamics for bypass oscillation is derived and is shown to agree reasonably well with the data. Author

**N65-12686*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**STABILITY AND CONTROL CHARACTERISTICS AT A MACH NUMBER OF 2.01 OF A VARIABLE-WING-SWEEP CONFIGURATION WITH OUTBOARD WING PANELS SWEPT BACK 75°**
M. Leroy Spearman and Gerald V. Foster Washington, NASA, Aug. 1959 19 p ref
(NASA-TM-X-32) OTS Prices: HC $1.00/MF $0.50
(Declassified)

An investigation has been conducted in a 4- by 4-foot supersonic pressure tunnel at Mach 2.01 to determine the stability and control characteristics of a variable-wing-sweep configuration with the outboard wing panels swept back 75°. The results indicated a reasonably linear variation of pitching moment with lift coefficient, so that the static margin could be reduced to about 5% in the low lift range before neutral stability would occur at higher lifts. The maximum lift–drag ratio for the untrimmed complete configuration was 6:1. Results for the complete configuration indicated positive directional stability up to an angle-of-attack of about 11° and positive dihedral effect throughout the angle-of-attack range investigated. Author

**N65-12687*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF A 0.067-SCALE MODEL OF THE X-15 AIRPLANE (CONFIGURATION 3) AT MACH NUMBERS OF 2.29, 2.98, AND 4.65**
Arthur E. Franklin and Robert M. Lust Washington, NASA, Nov. 1959 170 p refs
(NASA-TM-X-38) OTS Prices: HC $5.00/MF $1.00
(Declassified)

A wind-tunnel investigation was made to determine the drag and the static longitudinal and lateral stability characteristics of a 0.067-scale model of the X-15 airplane. The investigation was made at Mach 2.29, 2.98, and 4.65. The effect of Reynolds number is shown by results taken at Reynolds numbers of about $0.5 \times 10^6$, $1.85 \times 10^6$, $2.28 \times 10^6$, $3.24 \times 10^6$, $4.0 \times 10^6$, and $4.43 \times 10^6$. Author

**N65-12688*#** National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.
**PRESSURE MEASUREMENTS OBTAINED IN FLIGHT AT TRANSONIC SPEEDS FOR A CONICALLY CAMBERED DELTA WING**
Earl R. Keener Washington, NASA, Oct. 1959 70 p refs
(NASA-TM-X-48) OTS Prices: HC $3.00/MF $0.75
(Declassified)

Pressure measurements were made in flight over the conically cambered delta wing of the Convair JF-102A airplane at Mach numbers up to 1.19. Maximum angles-of-attack tested ranged from 24° at Mach 0.70 to 9° at 1.19. Appreciably large suction pressures are realized at the leading edge of the wing similar in magnitude to the high suction pressures experienced by thin, plane, delta wings. The cambered leading edge is effective in distributing the low pressures at the leading edge over a greater frontal area, thus increasing the leading-edge thrust. The conical distribution of camber results in near-elliptic span-load distributions at the lower angles-of-attack; however, a more important effect of conical camber (together with the wing fences and reflexed tips incorporated by the JF-102A) is the delay to higher angles-of-attack in the occurrence of flow separation that normally occurs on a plane delta wing. A wide variation occurs in the span-load distributions from a near-elliptic loading at the lower angles-of-attack to a near-triangular loading at the very high angles-of-attack tested. In general, the distributions are similar to those of a plane wing, although the delay in flow separation in the tip region results in slightly larger tip loads. Author

**N65-12689*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**PERFORMANCE OF A STRAIGHT STATOR AND A TILTED STATOR TESTED WITH A HIGH-SOLIDITY HIGH-PRESSURE-RATIO TRANSONIC ROTOR**
Ralph L. Schacht, Richard R. Cullom, and Arthur W. Goldstein Washington, NASA, Oct. 1959, 36 p refs
(NASA-TM-X-99) OTS Prices: HC $2.00/MF $0.50
(Declassified)

An investigation was conducted to determine the overall stage and stator blade-element performance with a straight stator and a tilted stator in a transonic axial-flow-compressor stage. The performance data were compared to observe the

effect of stator blade tilt on the weight-flow range. Both sets of stator blades were designed to operate near the rotor stall point and to attain the same performance level. The tilted stator did not achieve the greater weight-flow range theoretically predicted. The acute corner made by the suction surface and the casing caused such high losses that they more than offset any gains predicted for tilted blades. The straight-stator stage developed a pressure ratio of 1.24 at a maximum efficiency of 0.92 and an equivalent weight flow of 28.5 pounds per second in Freon 12 at the stator design speed of 288 fps. For the tilted-stator stage, the pressure ratio, efficiency, and weight flow were 1.22, 0.85, and 31.6, respectively. Author

**N65-12690*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**A COMPARISON OF THE PERFORMANCE OF FOUR SIDE-MOUNTED INLETS OVER A MACH NUMBER RANGE OF 0.88 TO 2.2 AND ANGLES OF ATTACK TO 14°**

Leroy L. Presley and William P. Peterson Washington, NASA, Jan. 1960 51 p refs

(NASA-TM-X-107) OTS Prices: HC $3.00/MF $0.50

(Declassified)

The performance of three external-compression inlets and one internal-compression inlet was investigated experimentally at Mach 2.0 through an angle-of-attack range from 0° to 14°. The external-compression inlets were as follows: a three-shock vertical-ramp inlet, a two-shock vertical-ramp inlet with a flow-deflector plate, and a three-shock horizontal-ramp inlet. The internal-compression inlet was a circular axisymmetric inlet with a translating centerbody. Each inlet was side-mounted on the forward portion of a 1/10-scale model of a fuselage large enough to accommodate four turbojet engines for operation at Mach 2.0. Each inlet captured the required airflow for two engines. Of the four investigated the internal-compression inlet with a flow-deflector plate and the horizontal-ramp inlet had the best pressure-recovery characteristics throughout the entire angle-of-attack range at Mach 2.0. Author

**N65-12691*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**FORCE, MOMENT, AND FLOW-FIELD CHARACTERISTICS OF TWO WING-BODY-NACELLE COMBINATIONS AT MACH NUMBERS 2 AND 3**

William A. Hill, Jr. Washington, NASA, Jan. 1960 93 p refs

(NASA-TM-X-111) OTS Prices: HC $3.00/MF $0.75

(Declassified)

Flow-field data and force and moment coefficients of wing, body, and engine nacelle combinations were obtained at angles-of-attack up to 23° and angles-of-sideslip of 0° and 5°. The Reynolds numbers, based on body length, were 5.9 and 10.4 million for the flow and force data, respectively. Two cylindrical bodies of fineness ratio 10 were employed. One, combined with an aspect-ratio-3/8 wing, had a tangent-ogive nose of fineness ratio 3, and the other, combined with an aspect-ratio-1 wing that extended to the body apex, had a Newtonian minimum-drag nose of fineness ratio 5. The engine nacelle, which was attached above or below the bodies, consisted of a straight-through duct of circular cross section. The length of the nacelle was 48% of the length of the bodies, and the maximum diameter of the nacelle was 80% of the diameter of the bodies. Author

**N65-12692*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**EFFECTS OF THREE SPANWISE TWIST VARIATIONS ON THE LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A THIN 45° SWEPTBACK HIGHLY TAPERED WING AT TRANSONIC SPEEDS**

John P. Mugler, Jr. Washington, NASA, Oct. 1959 39 p refs

(NASA-TM-X-126) OTS Prices: HC $2.00/MF $0.50

(Declassified)

Tests were conducted at transonic speeds on four wings: an untwisted wing to serve as a reference, and wings with linear, quadratic, and cubic twist variations across the span. All of the twisted wings had 0° twist at 10% of the semispan and 6° washout at the tip. The tests covered a Mach number range from 0.80 to 1.20 and an angle-of-attack range from −4° to 20°. Data were taken at stagnation pressures of 0.5 and 1.0 atm, which corresponded to Reynolds numbers of about $1.4 \times 10^6$ and $2.8 \times 10^6$, respectively, based on the wing mean aerodynamic chord. The wings have an aspect ratio of 4, taper ratio of 0.15, and 45° sweepback of the quarter-chord line. The wings were cambered and had a thickened root section. Wing twist produced a pitching-moment shift at low lift in the direction to reduce trim drag. The twist was also responsible for an increase in the minimum drag coefficient over the Mach number range, which resulted in decreases in the untrimmed maximum lift–drag ratio. Author

**N65-12694*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**HIGH-SUBSONIC-SPEED INVESTIGATION OF THE STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF SEVERAL DELTA-WING CONFIGURATIONS FOR ANGLES OF ATTACK FROM 0° TO 90°**

Bernard Spencer, Jr. Washington, NASA, Dec. 1959 28 p refs

(NASA-TM-X-168) OTS Prices: HC $2.00/MF $0.50

(Declassified)

An investigation was made in a high-speed 7- by 10-foot tunnel at high subsonic speeds to determine the effect of planform geometry on the static longitudinal aerodynamic characteristics of triangular planform models at angles-of-attack from approximately 0° to 90°. The wings had leading-edge sweeps of 55°, 59°, 63°, and 73°. These wings were also tested with folding-type panels located at the wing tip to provide pitch control and increase stability. Variation in planform of these wing-tip panels included varying the leading-edge sweep from 33.5° to 48° and the ratio of tip-panel area to wing area from 0.20 to 0.40. Author

**N65-12697*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**STABILITY AND CONTROL CHARACTERISTICS AT MACH NUMBERS OF 2.50, 3.00, AND 3.71 OF A VARIABLE-WING-SWEEP CONFIGURATION WITH OUTBOARD WING PANELS SWEPT BACK 75°**

Gerald V. Foster Washington, NASA, Jan. 1960 35 p refs

(NASA-TM-X-267) OTS Prices: HC $2.00/MF $0.50

(Declassified)

A wind-tunnel investigation was conducted at Mach 2.50, 3.00, and 3.71 to determine the static longitudinal and lateral stability and control characteristics of a variable-wing-sweep configuration with the outboard wing panels swept back 75°. The results indicate that, in general, an increase in Mach number resulted in decreases in static margin, maximum untrimmed lift–drag ratio, and directional stability. Increasing the tail dihedral angle from −15° to −60° resulted in a decrease in static margin and an increase in directional stability throughout the Mach number range. Author

**N65-12700*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**PERFORMANCE OF A MACH 3.0 EXTERNAL-INTERNAL-COMPRESSION AXISYMMETRIC INLET AT MACH NUMBERS FROM 2.0 TO 3.5**

Leonard E. Stitt and Reino J. Salmi Washington, NASA, Jan. 1960 21 p refs
(NASA-TM-X-145) OTS Prices: HC $1.00/MF $0.50
(Declassified)

A Mach 3.0 axisymmetric inlet having both external and internal compression was evaluated in a 10- by 10-foot supersonic wind tunnel at Mach numbers from 2.0 to 3.5. At Mach 3.0 a peak recovery of 83% was obtained with 4.5% bleed on the center body ahead of the throat and a cowl pressure drag coefficient of 0.012, based on maximum cross-sectional area. At Mach 2.0 the recovery increased to 90.5% and the cowl pressure drag coefficient decreased to 0.009. An additional 7.5% bleed in the subsonic diffuser increased the recovery from 83% to 87% at the design speed. Author

**N65-12701*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**AN INVESTIGATION OF THE EFFECTS OF NOSE AND LIP SHAPES FOR AN UNDERSLUNG SCOOP INLET AT MACH NUMBERS FROM 0 TO 1.9**
Frank A. Pfyl Washington, NACA, 18 Nov. 1955 61 p refs
(NACA-RM-A55G13) OTS Prices: HC $3.00/MF $0.75
(Declassified)

The underslung nose-scoop inlet was able to operate at Mach numbers from 0.6 to 1.9 over a large positive angle-of-attack range without adverse effects on the pressure recovery. Although there was no one inlet configuration that was markedly superior over the entire range of operating variables, the arrangement having a nose designed to give increased supersonic compression at low angles-of-attack, and a sharp lip showed the most favorable performance characteristics over the supersonic Mach number range. Inlets with sizable lip radii gave satisfactory performance up to a Mach number of 1.5; however, as a result of an increase in drag, the performance of such inlets was markedly inferior to the sharp-lip configuration above Mach numbers of 1.5. Throughout the range of test Mach numbers all inlet configurations evidenced stable airflow characteristics over the mass-flow range for normal engine operation. Author

**N65-12702*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**AN EXPERIMENTAL INVESTIGATION OF THE STATIC LONGITUDINAL STABILITY AND CONTROL CHARACTERISTICS OF A WINGLESS MISSILE CONFIGURATION AT MACH NUMBERS FROM 3.0 TO 6.3**
Hermilo R. Gloria Washington, NACA, 24 Jun. 1958 30 p refs
(NACA-RM-A58C20) OTS Prices: HC $2.00/MF $0.50
(Declassified)

The test configuration consisted of a fineness-ratio-5 minimum-drag nose, a fineness-ratio-5 cylindrical midsection, and a conical tail flare. The stabilizing flare consisted of a frustum of a fineness-ratio-5 cone extending two diameters forward of the base and increasing the base diameter by a factor of $\sqrt{2}$. The variation of lift coefficient with pitching-moment coefficient for the basic configuration with control undeflected was essentially linear, and the stability increased slightly with increasing Mach number. For a given control deflection, trim lift coefficients decreased with increasing Mach number as a result of the loss in control effectiveness and of an increase in stability of the basic configuration. Maximum trim lift-drag ratios between 2 and 2.5 were obtained, and were about 30 percent lower than the maximum lift-drag ratios of the basic configuration. At zero angle-of-attack, predictions with impact theory were found to be in good agreement with experimental results for incremental forces due to control deflection. At angle-of-attack, however, impact theory underestimated control effectiveness at low Mach numbers and overestimated effectiveness at high Mach numbers. Author

**N65-12705*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**PERFORMANCE OF A DOUBLE-RAMP SIDE INLET WITH COMBINATIONS OF FUSELAGE, RAMP, AND THROAT BOUNDARY-LAYER REMOVAL, MACH NUMBER RANGE, 1.5 TO 2.0**
Paul C. Simon Washington, NACA, 22 Oct. 1956 34 p refs
(NACA-RM-E56G09a) OTS Prices: HC $2.00/MF $0.50
(Declassified)

The performance of a double-ramp side inlet was investigated with various combinations of fuselage, ramp, and internal throat boundary-layer removal at free-stream Mach numbers of 1.5 to 2.0. The installation of inlet side fairings produced a 4% increase in net propulsive thrust when the inlet was matched to a hypothetical turbojet engine at a Mach number of 2.0. There was, however, a concomitant large reduction in subcritical stability. The side fairings were ineffective at Mach numbers of 1.5 and 1.8. When a slotted throat bleed and ramp perforations were applied to the inlet, an additional 4% increase in net propulsive thrust was realized. No subcritical stability was observed at a Mach number of 2.0. Increase in net thrust of 4% at Mach numbers of 1.5 and 1.8 was realized when the ramp boundary layer was bled through ramp and throat perforations. In addition, inlet stability range and diffuser-exit total-pressure distortions were improved. In each case investigated, it was necessary to divert two-thirds or more of the fuselage boundary layer to obtain maximum inlet performance. Author

**N65-12710*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**EXPERIMENTAL INVESTIGATION OF A HIGH SUBSONIC MACH NUMBER TURBINE HAVING A 40-BLADE ROTOR WITH ZERO SUCTION-SURFACE DIFFUSION**
William J. Nusbaum, Charles A. Wasserbauer, and Cavour H. Hauser Washington, NACA, 16 Jan. 1958 23 p refs
(NACA-RM-E57J22) OTS Prices: HC $1.00/MF $0.50
(Declassified)

An experimental turbine was designed for a high weight flow per unit frontal area, a high specific work output, a relative critical velocity ratio of 0.82 at the rotor hub inlet, and zero rotor blade suction-surface diffusion. At the equivalent design blade speed and work output, the brake internal efficiency based on the actual overall total-pressure ratio was 0.899. This value is 0.028 greater than the efficiency of a turbine with the same velocity diagrams and approximately the same solidity but with high rotor blade suction-surface diffusion. The calculated value of the ratio of effective rotor blade momentum thickness to mean camber length of 0.0103 is in very good agreement with the values previously obtained for transonic turbines having the same average total surface diffusion parameter. This value is much smaller than that obtained from a turbine having the same velocity diagrams but with high rotor blade suction-surface diffusion. These results indicate that low suction-surface diffusion is essential for minimum overall losses through a turbine-rotor blade row. Author

N65-12711*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**HIGH MACH NUMBER, LOW-COWL-DRAG, EXTERNAL-COMPRESSION INLET WITH SUBSONIC DUMP DIFFUSER**
James F. Connors and Richard J. Flaherty Washington, NACA, 12 May 1958 20 p refs
(NACA-RM-E58A09) OTS Prices: HC $1.00/MF $0.50
(Declassified)

A zero-cowl-drag, all-external-compression inlet with an abrupt area discontinuity or subsonic dump diffuser has been proposed and demonstrated for high Mach number application. Isentropic compression was focused at the lip of a cylindrical cowl and limited by the requirements for shock attachment. Theoretical calculations of the performance of such an inlet showed that it may be suited for application at Mach numbers of 4 and above. In an experimental investigation at Mach 3.85, a 4.75-inch-diam inlet attained a total-pressure recovery of 0.41 at a corresponding mass-flow ratio of 0.92. Subsonic diffusion over an area ratio of about 3.5 to 1.0 was accomplished in 1.25-inch-inlet diameters. Essentially no difference in performance was obtained in a comparison of the dump and a conventional subsonic diffuser. On a range basis, the overall performance of this inlet was at least comparable with that of the best on-design isentropic external-compression inlet previously reported. A variable Mach number configuration utilizing a telescoping spike with a subsonic dump diffuser is also included. Author

N65-12714*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**DRAG MEASUREMENTS AT LOW LIFT OF A FOUR-NACELLE AIRPLANE CONFIGURATION HAVING A LONGITUDINAL DISTRIBUTION OF CROSS-SECTIONAL AREA CONDUCTIVE TO LOW TRANSONIC DRAG RISE**
Russell N. Hopko, Robert O. Piland, and James R. Hall Washington, NACA, 18 Nov. 1953 18 p refs
(NACA-RM-L53E29) OTS Prices: HC $1.00/MF $0.50
(Declassified)

A procedure based on the transonic area rule was used to design a four-nacelle delta-wing airplane configuration. A flight test of a model of the configuration showed a zero-lift transonic drag rise of 0.010 which, when compared with estimates, indicated the absence of adverse interference effects. A body of revolution with the same longitudinal distribution of cross-sectional area as the configuration was also flight tested, and its measured transonic drag rise agreed with that of the configuration, thereby confirming the validity of the transonic drag rule for a complex aircraft configuration. Author

N65-12715*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**AERODYNAMIC LOADS ON AN EXTERNAL STORE ADJACENT TO A 60° DELTA WING AT MACH NUMBERS FROM 0.75 TO 1.96**
William M. Hadaway Washington, NACA, 24 Apr. 1956 47 p refs
(NACA-RM-L56B02A) OTS Prices: HC $2.00/MF $0.50
(Declassified)

An investigation has been made in a 9- by 12-inch blowdown tunnel to determine separately the aerodynamic characteristics of both an external store and a semispan delta-wing–fuselage configuration in the presence of each other. The store was located at the 50-percent-semispan station with the store nose both ahead of and behind the wing leading edge for two longitudinal and three vertical positions. Data were obtained through a Mach number range from 0.75 to 1.96 and at angles-of-attack from −3° to 12°. The test Reynolds numbers were between $2.3 \times 10^6$ to $3.1 \times 10^6$. Limited effects of pylon modification were also obtained at Mach 1.62. Author

N65-12717*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**AERODYNAMIC FORCES AND MOMENTS ON A LARGE OGIVE-CYLINDER STORE AT VARIOUS LOCATIONS BELOW THE FUSELAGE CENTER LINE OF A SWEPT-WING BOMBER CONFIGURATION AT A MACH NUMBER OF 1.61**
Odell A. Morris Washington, NACA, 14 Jan. 1957 45 p
(NACA-RM-L56I25) OTS Prices: HC $2.00/MF $0.50
(Declassified)

A supersonic wind-tunnel investigation on store interference has been conducted in a 4- by 4-foot supersonic pressure tunnel at Mach 1.61. Forces and moments were measured on a large ogive-cylinder store in the presence of a 45° swept-wing–fuselage bomber configuration for a number of store locations below the fuselage center line. Results of the investigation show that large variations of store lift, drag, and pitch occur with changes in store or airplane angle-of-attack, store vertical location, and store horizontal location. The variation of the store forces and moments with respect to the chordwise location of the wing planform indicates that the wing is a large factor in producing the interference loads on the store. Comparison of data for underfuselage and underwing store locations at an angle-of-attack of 0° showed maximum store drag interferences of similar magnitudes, but showed considerably smaller maximum interference on store lift and pitching moments for underfuselage store locations. Author

N65-12720*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**AN INVESTIGATION OF SOME EFFECTS OF MACH NUMBER AND AIR TEMPERATURE ON THE HYPERSONIC FLOW OVER A BLUNT BODY**
Alvin Seiff and Simon C. Sommer Washington, NASA, Feb. 1959 25 p refs
(NASA-Memo-10-9-58A) OTS Prices: HC $1.00/MF $0.50
(Declassified)

Tests were made with a blunt body in hypersonic free flight through air to investigate the validity of the flow-field "freeze" rule over a range of Mach numbers from 3.25 to 15 and a range of real-gas stagnation temperatures from 1600° to 6600° R. Measurements included drag, static stability, shock-wave shape and standoff distance, wake convergence angle, and boundary-layer transition point. Results are analyzed to define effects of Mach number, total enthalpy, Reynolds number, and transition point on the measured quantities. Author

N65-12722*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**USE OF STAGE-STACKING TECHNIQUE FOR PREDICTING OVER-ALL PERFORMANCE IN MULTISTAGE AXIAL-FLOW COMPRESSOR UTILIZING INTERSTAGE-AIR BLEED**
James G. Lucas Washington, NASA, Oct. 1958 49 p refs
(NASA-MEMO-10-4-58E) OTS Prices: HC $2.00/MF $0.50
(Declassified)

An experimental investigation was conducted to determine the changes in overall compressor performance and stage and

stage-group characteristics of a 13-stage axial-flow compressor due to interstage-air bleed over the fifth- and tenth-stage rotor blade rows, both separately and together. Bleed tended to alter the contours of the stage performance characteristic curves. Fifth-stage bleed, alone or in combination with tenth-stage bleed, tended to improve the medium and low-speed performance of the four stages preceding it, and tended to reduce the performance of the five succeeding stages as a group. Tenth-stage bleed alone had no appreciable effect on the performance of preceding stages, but did tend, along with the combination bleed, to move the characteristic curves of the succeeding stages to lower values of flow coefficient. Author

**N65-12723*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**FREE-FLIGHT INVESTIGATION OF THE DRAG OF A 60° DELTA-WING CONFIGURATION WITH LARGE STORES MOUNTED BELOW THE INDENTED FUSELAGE AT MACH NUMBERS BETWEEN 0.8 AND 1.6**
Sherwood Hoffman Washington, NASA, Oct. 1958 31 p refs
(NASA-Memo-10-9-58L) OTS Prices: HC $2.00/MF $0.50
(Declassified)

Free-flight tests near zero lift were conducted between Mach numbers 0.8 and 1.6 to determine the drag of 60° delta-wing configuration with large stores under the fuselage. The fuselage was indented for M = 1.0 to cancel only the wing areas. Three finned stores with fineness ratios of 8, 10, and 12 and with equal volume were mounted on struts and tested in the region of the fuselage indentation. The vertical displacement of the stores was held constant. Small-scale models of the isolated stores also were tested. Increasing the store fineness ratio from 8 to 10 to 12 resulted in successive reductions in total drag. Unfavorable interference effects were obtained from each store through the Mach number range, except for the fineness-ratio-12 store at the higher supersonic Mach numbers. The agreement obtained between the measured pressure drags and those calculated from the supersonic-area-rule theory ranged from good to poor for the models with stores. Author

**N65-12724*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**PRELIMINARY TRANSONIC PERFORMANCE RESULTS FOR SOLID AND SLOTTED TURBOJET NACELLE AFTERBODIES INCORPORATING FIXED DIVERGENT JET NOZZLES DESIGNED FOR SUPERSONIC OPERATION**
Jack F. Runckel Washington, NASA, Dec. 1958 44 p refs
(NASA-Memo-10-24-58L) OTS Prices: HC $2.00/MF $0.50
(Declassified)

An investigation of three fixed afterbody-jet exit configurations designed for supersonic speeds has been conducted in the Langley 16-ft transonic tunnel. A fixed divergent ejector, a similar ejector with longitudinal slots, and a boattail with terminal bodies extending beyond a convergent nozzle were studied. The afterbodies were installed on a pylon-supported nacelle model, and the performance of the configurations was determined at Mach numbers from 0.80 to 1.06 at an angle-of-attack of 0° with jet total-pressure ratios from 1 (jet off) to about 8. A hydrogen peroxide jet simulator was used to supply the hot jet exhaust. All configurations were tested without secondary air-flow. The results of the investigation indicate that the terminal-fairing configuration had the highest thrust-minus-drag coefficients of the three configurations at all Mach numbers and the lowest effective drag with afterburner nozzles. Flow attachment hysteresis on the divergent ejector nozzle was eliminated by the addition of longitudinal slots. Author

**N65-12797*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**INVESTIGATION OF AERODYNAMIC CHARACTERISTICS AT HIGH SUBSONIC SPEEDS OF TWO SUPERSONIC-CRUISE AIRPLANE CONFIGURATIONS HAVING TAIL SURFACES OUTBOARD OF THE WING TIPS**
Paul G. Fournier and William C. Sleeman, Jr. Washington, NASA, Aug. 1960 63 p refs
(NASA-TM-X-293) OTS Prices: HC $3.00/MF $0.75
(Declassified)

The aerodynamic characteristics at high subsonic speeds of two outboard-tail airplane configurations have been investigated in a high-speed 7- by 10-foot tunnel from Mach 0.40 to 0.94. The models had the horizontal and vertical tail surfaces mounted on slender bodies attached to the tips of a low-aspect-ratio highly sweptback wing. One model had a 70° sweptback wing that had both twist and negative dihedral, and the other model had a 60° sweptback wing that had no twist or dihedral. Both models had simulated engine installations attached that represented a six-engine arrangement having a common air inlet with airflow through the inlet. The static longitudinal and lateral stability and control characteristics were obtained over an angle-of-attack range from about –2° to 24°. Author

**N65-12799*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**RESEARCH ON BLUNT-FACED ENTRY CONFIGURATIONS AT ANGLES OF ATTACK BETWEEN 60° AND 90°**
William H. Phillips Washington, NASA, Sep. 1960 15 p refs
(NASA-TM-X-315) OTS Prices: HC $1.00/MF $0.50
(Declassified)

This paper summarizes the aerodynamic characteristics and stability and control of reentry vehicles operating in the angle-of-attack range between 60° and 90°. Both capsule shapes and winged-reentry-type vehicles are considered. A stable pitching-moment slope exists for the high angles-of-attack. However, a lack of aerodynamic damping makes stability augmentation necessary. By change in the blunt-face curvature, both positive and negative lift-curve slopes can be obtained. Control can be obtained by vane-type flaps deflected to shift the centroid of area. The control effectiveness is good and reasonably linear for control deflections greater than 30° from the stream direction. It appears that at angles-of-attack near 90° the aerodynamic characteristics, which depend upon pressure forces on the front face, are predictable and independent of Mach number. Heat transfer and flow fields are difficult to predict, but some experimental data are presented. Author

**N65-12800*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**EFFECTS OF WING HEIGHT ON THE STABILITY AND CONTROL CHARACTERISTICS AT A MACH NUMBER OF 2.01 OF A CANARD AIRPLANE CONFIGURATION WITH A 70° DELTA WING**
Cornelius Driver Washington, NASA, Sep. 1960 31 p refs
(NASA-TM-X-328) OTS Prices: HC $2.00/MF $0.50
(Declassified)

An investigation was made in a 4- by 4-foot supersonic pressure tunnel at Mach 2.01 to determine the effects of wing height on the stability and control characteristics of a canard airplane configuration with wing and canard surfaces of 70° delta planform. The configurations were tested with a vertical tail mounted on the body plane of symmetry and with twin tails mounted on the wing at about the 50-percent-semispan location. The low-wing configuration with the body-mounted vertical tail

had the highest trim values of lift-curve slope, control effectiveness, and lift–drag ratio of the configurations tested. The positioning of the vertical tails outboard on the wing caused a reversal in the wing-height effects on the directional-stability level, and the high-wing configuration maintained the highest level of directional stability. Author

**N65-12801*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**EFFECTS OF CANTED FORWARD FACES ON THE STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF THE ESCAPE AND EXIT CONFIGURATIONS OF A PROJECT MERCURY CAPSULE MODEL AT A MACH NUMBER OF 2.01**
Roy V. Harris, Jr. and Ross B. Robinson Washington, NASA, Oct. 1960 16 p ref
(NASA-TM-X-339) OTS Prices: HC $1.00/MF $ 0.50
(Declassified)

An investigation was made in a 4- by 4-foot supersonic pressure tunnel at Mach 2.01 to determine the aerodynamic characteristics in pitch of the escape and exit configurations of the proposed Project Mercury capsule. The forward faces of the two configurations were canted to provide a few degrees of trim angle-of-attack, and several cant angles were investigated. The results indicate that, by canting the forward faces of the configurations, relatively large increments in pitching moment can be obtained at Mach 2.01 with little change in lift and drag. Author

**N65-12803*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**EFFECTS OF WING INCIDENCE ON THE LONGITUDINAL TRIM CHARACTERISTICS OF A CAMBERED 70° DELTA-WING CONFIGURATION AT MACH NUMBERS 3.0 TO 5.0**
Warren F. Ahtye Washington, NASA, Sep. 1960 53 p refs
(NASA-TM-X-374) OTS Prices: HC $2.00/MF $0.50
(Declassified)

Tests were conducted at Mach 3.0 to 5.0 on a delta-wing and body configuration to determine the effect of wing camber and incidence on the trim characteristics of the configuration. It was found that for an assumed moment reference that insures static longitudinal stability from subsonic speeds up to Mach 5.0, the combined use of incidence and camber is required to trim the configuration at the attitude for maximum lift–drag ratio. The attendant loss in the maximum lift–drag ratio was 10% and is attributed entirely to the effect of camber. If a reference moment center were chosen so that static longitudinal stability existed up to Mach 3.0 only, then the trim requirements would be less stringent. As a result—through the use of only the limited incidence tested, the configuration could be trimmed at Mach 3.0 with no loss in maximum lift–drag ratio. Author

**N65-12806*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**STEADY AND FLUCTUATING PRESSURES AT TRANSONIC SPEEDS ON HAMMERHEAD LAUNCH VEHICLES**
Charles F. Coe and James B. Nute Washington, NASA, Dec. 1962 47 p refs
(NASA-TM-X-778) OTS Prices: HC $2.00/MF $0.50
(Declassified)

Steady and fluctuating pressures have been measured along the top center lines of three space-vehicle models with hammerhead-shaped profiles at Mach 0.60 to 1.17. The results of the investigation showed that flow separation due to the hammerhead configuration can expose large areas of the vehicle to significant pressure fluctuations. The model with the largest hammerhead profile had the highest fluctuations due to separation and also the greatest length of significant unsteady flow. These relatively large fluctuations occur at subsonic speeds and can also occur at supersonic speeds if the ratio of diameters between the payload and following rocket stage is large. The intensities of the fluctuations in the region of the shock wave on the first-stage booster were increased when noticeable separation effects extended onto the interstage flare. Measurements of representative power spectral densities of the fluctuations within the separated flow on the three models showed that the spectra were relatively flat over the measured range of frequencies. Author

**N65-12820#** Aeronautical Research Labs., Melbourne (Australia).
**SUPERSONIC INTAKE INSTABILITY—FURTHER INVESTIGATION OF INTAKES OF 25° CONE SEMI-ANGLE AT MACH NUMBERS UP TO 2.14 WITH & WITHOUT BOUNDARY LAYER BLEED**
D. G. Stewart Jan. 1964 64 p refs
(ARL/ME-112)

Tests on the plain cone models (those not modified for bleed) at M = 2.00 and 2.14 showed behavior similar to that at M = 1.83, indicating that subsonic diffuser design had little effect on stability at extreme values of cowl lip position angle (32° and 40°), whereas at intermediate values a long diffuser throat resulted in improved stability. This effect was most pronounced at M = 1.83, much smaller at M = 2.00, and almost imperceptable at M = 2.14, indicating that shock-induced separation occurred more easily as Mach number increased. Amplitudes and frequency of oscillation generally were similar at the higher Mach numbers to those at M = 1.83, but Ferri instability characteristics were modified by boundary-layer effects. Simultaneous pressure records and spark shadowgraphs indicate that instability occurs, not as soon as boundary-layer separation starts, but when pressure recovery is reduced as a result of boundary-layer separation. The effect of boundary-layer bleed on the cone surface was to improve stability in those models in which instability occurs by boundary-layer separation but not by Ferri instability. The most effective bleed locations were always those somewhat upstream of the last, stable, normal shock position without bleed. M.P.G.

**N65-12835#** Deutsche Versuchsanstalt für Luft- und Raumfahrt, Aachen (W. Germany). Inst. für Angewandte Gasdynamik
**INFLUENCE OF FINITE SPAN AT THE TRAILING EDGE OF LOW ASPECT RATIO WINGS OR FINITE CROSS-SECTIONAL AREA AT THE APEX OF POINTED SLENDER BODIES OF REVOLUTION ON THE FLOW ON THE BODY AND BEHIND IT [EINFLUSS ENDLICHER SPANNWEITE ODER ENDLICHER FLACHE IM ENDQUERSCHNITT VORN SPITZER FLUGEL KLEINER STRECKUNG ODER SCHLANKER ROTATIONSKORPER AUF DIE STROMUNG AM UND HINTER DEM KORPER]**
Friedrich Keune Sep. 1964 61 p refs In GERMAN; ENGLISH summary
(DLR-FB-64-21; DVL-365) Available from ZLDI, Munich: DM 14.50

From linearized flow theory influences are derived, by which the useful analytical and physical results of slender-body theory are extended to a general formulation and are no longer restricted to simple body geometry or to supersonic flow. The theory is valid in subsonic flow also or for combined planforms of wings or bodies. The principles of the new development are shown for subsonic flow conditions with enlarged boundary conditions for the body shapes. Expansions to supersonic flow

or for high aspect ratio wings follow the same analytical procedure. The theory contains the proof that higher approximations are proportional to even-powered cross-sectional distances, which is important in the iteration method for fulfilling the boundary condition on given body shapes. Author

**N65-12930#** Systems Research Labs., Inc., Dayton, Ohio.
**HYPERSONIC FLOW OVER BLUNT SLAB WINGS WITH SWEEP ANGLES FROM 0 TO 70 DEGREES**
W. D. Vann Wright-Patterson AFB, Ohio, ARL, Oct. 1964 99 p refs
(Contract AF 33(616)-7987)
(ARL-64-171; AD-609054)

An experimental and theoretical investigation was made to determine the pressure distributions over swept wings in hypersonic flow. Two models having hemicylindrical leading edges were tested in a 20-inch hypersonic wind tunnel. Tests were made over an angle-of-attack range of ±25° at five-degree increments for the sweep angles 0°, 50°, 60°, and 70° at a nominal test Mach number of 14 and a Reynolds number of 35 000 based on the nose diameter of the models. The test data measured on the nose region were in fair agreement with the theoretical pressure distributions for each sweep angle and appeared to be independent of Mach number as expected. At angles-of-attack up to 15° and 25°, the flow over the expansion and compression surfaces appeared to be two dimensional. Fairly good agreement was obtained between the measured test data and an inviscid theoretical analysis based on a modification of the blast-wave theory. Author

**N65-12988#** Bell Aerosystems Co., Buffalo, N.Y.
**NONLINEAR THERMOELASTIC EFFECTS ON HYPERSONIC STABILITY AND CONTROL. PART I, VOLUME I: AERODYNAMICS**
James R. Batt Wright-Patterson AFB, Ohio, AF Flight Dyn. Lab., Sep. 1964 82 p refs
(Contract AF 33(657)-7486)
(FDL-TDR-64-16, Pt. I, Vol. I; AD-608469)

Linnell's pressure-prediction method is used as a basis for developing hypersonic, aerodynamic influence-coefficient matrices. The method accounts for the nonlinear variation of lifting pressure with angle-of-attack, which is present at hypersonic speeds. Comparisons of theoretical and experimental hypersonic pressure distributions are made. Author

**N65-12989#** Bell Aerosystems Co., Buffalo, N.Y.
**NONLINEAR THERMOELASTIC EFFECTS ON HYPERSONIC STABILITY AND CONTROL. PART II: ANALYTICAL AND EXPERIMENTAL STATIC AEROTHERMOELASTICITY**
James R. Batt and Richard H. Gallagher Wright-Patterson AFB, Ohio, AF Flight Dyn. Lab., Oct. 1964 96 p refs
(Contract AF 33(657)-7486)
(FDL-TDR-64-16, Pt. II; AD-608476)

An analytical method was developed for the analysis of static aerothermoelastic behavior in the presence of nonlinear aerodynamic loads and geometrically nonlinear structural behavior. The method was programed for the IBM 7090 digital computer using FORTRAN coding techniques. A system for the experimental determination of static aerothermoelastic response of nonuniformly heated structures to loadings that are a nonlinear function of wing surface slopes was developed. Results of this experimental program are presented and compared with theoretical predictions. Author

**N65-13043#** Martin Co., Orlando, Fla.
**RECIRCULATION PRINCIPLE FOR GROUND EFFECT MACHINE: PRELIMINARY DESIGN OF A RESEARCH VEHICLE**
J. Burns, K. Cossairt, and M. Rosenberg Ft. Eustis, Va., Army Transportation Res. Command, Aug. 1964 295 p refs
(Contract DA-44-177-AMC-96(T))
(OR-3725-1; TRECOM-TR-64-27; AD-608523)

The ejector recirculation lift system was investigated as a means of improving the internal-flow and performance characteristics of air cushion vehicles. The concept permits larger unobstructed stowage areas and lower structural weight. The system minimizes the performance degradation of air cushion vehicles associated with higher speed and increased base pressure. The study involved two phases: ejector optimization and fabrication of an air source having the mass flow, and pressure characteristics necessary for a vehicle of moderate size. The results indicate that an energy recovery system of this type is feasible, and that performance may be predicted with the same degree of accuracy as for conventional axial flow fan–duct–nozzle systems. Author

**N65-13059#** Grumman Aircraft Engineering Corp., Bethpage, N.Y. Research Dept.
**PRESSURE AND HEAT TRANSFER MEASUREMENTS FOR MACH 8 FLOWS OVER A BLUNT PYRAMIDAL CONFIGURATION WITH AERODYNAMIC CONTROLS. PART II: PRESSURE DATA FOR DIHEDRAL SURFACES. PART OF AN INVESTIGATION OF HYPERSONIC FLOW SEPARATION AND CONTROL CHARACTERISTICS**
Louis G. Kaufman, II Wright-Patterson AFB, Ohio, AF Flight Dyn. Lab., Sep. 1964 178 p refs
(Contract AF 33(616)-8130)
(FDL-TDR-64-2, Pt. II; AD-608441)

Pressure and heat-transfer data were obtained for Mach 8 flows over a blunt pyramidal configuration composed of a 70° sweepback delta wing surface and two dihedral surfaces. Trailing edge flap deflections were varied up to 40° on all surfaces, and the model was tested with and without canards and ventral fins. The model was pitched at angles-of-attack between ±54° and was tested at sideslip angles of 0° and 12° for free-stream Reynolds numbers, based on model length, of 1.5 and 4.5 million. Author

**N65-13060#** Cornell Aeronautic Lab., Inc., Buffalo, N.Y.
**FLIGHT EVALUATION OF VARIOUS SHORT PERIOD DYNAMICS AT FOUR DRAG CONFIGURATIONS FOR THE LANDING APPROACH TASK**
Charles R. Chalk Wright-Patterson AFB, Ohio, AF Flight Dyn. Lab., Oct. 1964 219 p refs
(Contract AF 33(657)-7442)
(FDL-TDR-64-60; AD-608620)

The T-33 variable stability and variable drag airplane was used. Pilot rating and comment data were collected and used to determine short period requirements for the landing approach task. The importance of the slope of the thrust required vs velocity curve is discussed and related to pilot comments and control difficulties. The longitudinal control gain selected by the pilot was a function of short period frequency and damping ratio. Curves relating control authority and short period frequency and damping ratio are derived from these data. The power-spectral density of the pilot's elevator stick motion was significantly affected by short period dynamics and atmospheric turbulence. Author

**N65-13092*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**THE EFFECTS OF NOSE BLUNTNESS ON THE PRESSURE FLUCTUATIONS MEASURED ON 15° AND 20° CONE-CYLINDERS AT TRANSONIC SPEEDS**
Charles F. Coe and Arthur J. Kaskey Washington, NASA, Jan. 1963 33 p refs
(NASA-TM-X-779) OTS Prices: HC $2.00/MF $0.50
(Declassified)

Pressure fluctuations have been measured along the top center lines of seven cylindrical bodies having noses with 15° and 20° cone–cylinder intersection angles and various amounts of hemispherical bluntness. A hemisphere cylinder was also tested. Tests were conducted at angles-of-attack of 0°, 4°, and 8° over a Mach number range within 0.60 to 1.17. The results of the investigation showed that pressure fluctuations in regions of separated flow or at the locations of shock waves were smaller on cylindrical bodies with 15° cone–cylinder intersection angles than with 20° intersection angles. Hemispherical blunting of the nose cones had little or no effect on the pressure fluctuations. Replacing the 15° or 20° half-angle cones with a hemisphere, however, resulted in increased fluctuations due to separation. Author

**N65-13230#** Michigan U., Ann Arbor. Coll. of Engineering
**INTERACTION EFFECTS OF A JET FLAP ON A 60° DELTA WING AT MACH NUMBER 4, AND COMPARISON WITH TWO-DIMENSIONAL THEORY**
James L. Amick and Gerard F. Carvalho Feb. 1963 38 p refs
(Contract NOrd-16595)
(CM-1031; AD-400609)

Measured normal force increments due to a jet flap issuing perpendicularly from a flat-plate wing are presented. Interaction effects caused a magnification of the jet force by a factor of 2.4 to 2.8, when the wing had a turbulent boundary layer. For a laminar boundary layer the jet force magnification ratio varied from 2.5 for the strongest jet tested, to 3.6 for a jet approximately one-tenth as strong. A three-fold change in slot width had very little effect on the interaction. The experimental results are compared with calculations based on a two-dimensional theory that makes use of empirical separation and base pressure data. The calculated interaction forces are larger than those obtained experimentally, but many of the trends are similar. The interaction is predicted to become increasingly more favorable as Mach number increases. At hypersonic speeds it is indicated that a jet flap wing may be competitive in lifting efficiency with a conventional wing at angle-of-attack, if operation at large lift coefficients is required. Author

**N65-13235#** Technische Hochschule Darmstadt (W. Germany). Inst. für Dampfkraftmaschinen
**CONTRIBUTION TO THE OPTIMIZATION OF AXIAL CASCADES [BEITRAG ZUR OPTIMALEN AUSLEGUNG VON AXIAL-SCHAUFELGITTERN]**
Horst Pfeil (Ph.D. Thesis) [1964] 76 p refs In GERMAN

Eight different uneven profiles in various positions were exposed to a turbulent coaxial flow in a wind tunnel to find an optimal design for axial cascades. Measurements of the downstream flow velocity and the optimal position of the profiles were evaluated, and the median optimal values were obtained and related to smooth hydraulic surfaces by equations. G.G.

**N65-13301*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**AERODYNAMIC CHARACTERISTICS OF BLUNT BODIES**
James O. Nichols and Edward A. Nierengarten 19 Nov. 1964 22 p refs
(Contract NAS7-100)
(NASA-CR-59914; JPL-TR-32-677) OTS Prices: HC $1.00/MF $0.50

The static aerodynamic characteristics of three related families of blunt bodies—spherically blunted cones, spherical segments, and round-shouldered circular cylinders—are presented. Data from tests of blunted cones are presented with data from tests to extend the ranges of test parameters. The ranges of parameters are given: cone half-angle from 10° to 60°; bluntness ratio (nose radius–base radius) from 0 to 1.0; and Mach number from 1.65 to 9.0 with some data at subsonic Mach numbers. The spherical segments and round-shouldered circular cylinders have not been as extensively investigated as the spherically blunted cones. This report presents the results of the first systematic tests of these bodies. Test data are compared with sharp cone and modified Newtonian theories. Author

# 02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

**N65-12716*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**FULL-SCALE WIND-TUNNEL TESTS OF A 35° SWEPT-WING FIGHTER AIRPLANE WITH A SPOILER-SLOT-DEFLECTOR LATERAL CONTROL SYSTEM**
William I. Scallion Washington, NACA, 26 Oct. 1956 74 p refs
(NACA-RM-L56D18) OTS Prices: HC $3.00/MF $0.75
(Declassified)

An investigation was made in the Langley full-scale tunnel to determine the low-speed aerodynamic characteristics of a 35° swept-wing fighter airplane with a segmented spoiler-slot-deflector lateral control system installed ahead of the conventional ailerons and operated as individual units and as combined segments. The longitudinal characteristics of the airplane and spoiler-slot-deflector effectiveness data were obtained through the complete angle-of-attack range with the ailerons neutral and with the ailerons drooped in conjunction with the normal flaps. Spoiler-deflector hinge-moment data were also obtained for a number of spoiler-deflector combinations. The test Reynolds number was $5 \times 10^6$ and the Mach number was 0.10. Author

**N65-12805*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**GROUND MEASUREMENTS OF SHOCK-WAVE PRESSURE FOR FIGHTER AIRPLANES FLYING AT VERY LOW ALTITUDES AND COMMENTS ON ASSOCIATED RESPONSE PHENOMENA**
Domenic J. Maglieri, Vera Huckel, and Tony L. Parrott Washington, NASA, Dec. 1961 64 p refs
(NASA-TM-X-611) OTS Prices: HC $3.00/MF $0.75
(Declassified)

Extensive ground measurements of shock-wave pressure have been made for two different supersonic fighter airplanes in the Mach number range of about 1.05 to 1.16 and for altitudes from about 50 to 890 ft. Comparisons of the pressure rises across the shock wave measured on the ground are made with the available theoretical data, and these pressure data are correlated with some data on window-glass breakage. Brief discussions are given relative to other associated phenomena, such as ground motions and response of equipment and personnel. The pressure-time histories measured at ground level were found to contain more peaks than would be obtained at ground level from flights at high altitudes. The measured values of pressure rise across the bow shock wave decreased with increasing altitude as predicted by theory. A higher percentage of failures generally occurred with increased peak pressure rise across the shock wave. It was also found that the detail

characteristics of the pressure–time histories are significant; more damage occurred for the time histories having longer time durations of the first positive pressure rise across the shock wave. Author

**N65-13044#** Aviation Safety Engineering and Research, Phoenix, Ariz.
**CRASH INJURY EVALUATION. PERSONNEL RESTRAINT SYSTEMS STUDY: UH-1A AND UH-1B BELL IROQUOIS HELICOPTERS**
Joseph L. Haley, Jr. and James P. Avery Ft. Eustis, Va., Army Transportation Res. Command, Mar. 1964 48 p refs
(Contract DA-44-177-AMC-888(T))
(AvSER-62-27; TRECOM-TR-63-81; AD-608192)

The crew and passenger restraint systems installed in the UH-1A and UH-1B aircraft are evaluated, and a practical method of modifying these systems to provide increased protection is proposed. The modifications proposed indicate the following strength improvements: (1) Cockpit—The crew's restraint system is increased from a 10 to 12 G value to a 20 to 25 G value. (2) Troop compartment—The troop's lap belt attachments are increased from a 12 to 15G value to a 22 to 25 G value. The above strength increases can be achieved with a weight increase of 7 pounds per aircraft and a cost of approximately $70 per aircraft. D.S.G.

**N65-13069#** Mississippi State U., State College.
**THE MARVEL PROJECT. PART C: AN INVESTIGATION OF THE SHROUDED PROPELLER PROPULSIVE SYSTEM ON THE MARVELETTE AIRCRAFT Aerophysics Research Report No. 48**
Sean C. Roberts Ft. Eustis, Va., Army Transportation Res. Command, Aug. 1964 81 p refs
(Contract DA-44-177-AMC-892(T))
(TRECOM-TR-64-41; AD-608187)

An attempt was made to develop a reasonably accurate method of designing a shrouded propeller for thrust augmentation. Full-scale flight results of a shrouded propeller on a pusher-type aircraft are presented and compared with the equivalent free-propeller and theoretical results developed from existing theories. The theoretical methods of shrouded-propeller design and performance predictions outlined are adequate although they tend to be optimistic. The static thrust of the investigated shrouded-propeller configuration was approximately 100 percent greater than the static thrust of the equivalent open propeller driven by the same horsepower engine. The results presented can be used either to predict the performance of a ducted-propeller configuration or, knowing the performance required, to design the ducted propeller. P.V.E.

**N65-13070#** Princeton U., N.J.
**THE DOMINANT AERODYNAMIC CHARACTERISTICS OF A SHAPED GEM**
A. F. Wojciechowicz, Jr., W. B. Nixon, and T. E. Sweeney Ft. Eustis, Va., Army Transportation Res. Command, Sep. 1964 51 p refs *Its* Rept.-684
(Contract DA-44-177-TC-850)
(TRECOM-TR-64-45; AD-608522)

The effects of aerodynamic forces and moments acting on a ground effect machine in forward flight are investigated in some detail. Emphasis has been placed upon the performance gains possible by shaping a GEM to maximize lift at zero degrees angle-of-attack. The associated longitudinal stability and trim problem is discussed, and at least one solution is presented. The work is both theoretical and experimental, the latter utilizing wind-tunnel models of a reconfigured P-GEM and also the full-scale P-GEM. Flight-test results prove the validity of the concept and are extrapolated to higher airspeeds than those attainable with the P-GEM. Author

**N65-13217#** Lockheed-California Co., Burbank.
**DEVELOPMENT OF A POWER SPECTRAL GUST DESIGN PROCEDURE FOR CIVIL AIRCRAFT Monthly Progress Report, Sep. 1–30, 1964**
F. M. Hoblit, N. Paul, and F. Ashford 8 Aug. 1964 81 p ref
(Contract FA-WA-4768)
(MPR-7)

Results are presented from a series of tests of various civil aircraft designs. Tests include dynamic analyses of vertical and lateral gusts, levels of $\sigma_w \eta_d$ and frequency of exceedance necessary to reach limit strength of airplanes, and effects of parameter variations on gust loads. D.E.W.

**N65-13249#** Lockheed-California Co., Burbank.
**DEVELOPMENT OF A POWER SPECTRAL GUST DESIGN PROCEDURE FOR CIVIL AIRCRAFT Monthly Progress Report, Jul. 1964**
F. M. Hoblit, N. Paul, and F. Ashford 8 Aug. 1964 81 p ref
(Contract FA-WA-4768)
(MPR-5)

The following topics are presented: "Generation of Design Conditions from Statistically Defined Loads—Vertical Gust"; "Design Load Level and Design Loads—Vertical Gust"; and "Mathematical Mode—Lateral Gust." The symmetric response of an airplane to one-dimensional sinusoidal gust excitation is analyzed under variable aerodynamic conditions. The aerodynamic coupling along the wing and between the wing and tail plane are the important factors that govern the responses of the flexible modes. A summary of the vertical and the lateral analysis input data in the form of panelled weights and inertia, elastic axis location, and the bending-torsion stiffness distribution is presented. The factor flight loads for the wing and body of each of thirteen mission profile conditions are also presented. G.G.

**N65-13307*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**FLIGHT INVESTIGATION OF STEEP INSTRUMENT APPROACH CAPABILITIES OF A C-47 AIRPLANE UNDER MANUAL CONTROL**
Albert W. Hall and Donald J. Mc Ginley, Jr. Washington, NASA, Jan. 1965 17 p refs
(NASA-TN-D-2559) OTS Prices: HC $1.00/MF $0.50

This study included an investigation of flare paths suitable for transition from the steep glide slope to a final terminal angle to touchdown. The maximum glide slope feasible for operational use in an instrument approach was 6° More pilot effort and concentration were required to fly the 6° glide slope than were required for the 2-1/2° slope, and the flight-path deviations were also somewhat greater for the 6° slope. The greatest problem during the approach or flare was the effort required to maintain the proper lateral directional control. In the opinion of most of the pilots, instrument approaches to touchdown could be made repeatedly with manual longitudinal control if lateral directional control was automatic. The most suitable flare paths were those requiring 4 to 6 seconds per degree of flight-path change from the 6° glide slope to the final terminal angle. Author

# 03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

**N65-12374#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INVESTIGATION OF PNEUMATIC AND HYDRAULIC SERVOMECHANISMS**
V. N. Chelomey *In its* Autom. Control and Computer Tech. 25 Aug. 1964 p 187–203 refs (See N65-12367 03-34)

Problems of the theory of pneumatic and hydraulic servomechanisms are discussed for the cases where the valve distribution is important in steering mechanisms. Fundamental diagrams of both types of machines are given, and their operation is compared. For identical parameters of the mechanism, the free pneumatic machine has significantly larger speed of response than the hydraulic machine. M.P.G.

**N65-12443*#** General Electric Co., Schenectady, N.Y.
**FLUID AMPLIFIER APPLICATIONS STUDIES**
Washington, NASA, Dec. 1964 158 p refs
(Contract NAS8-5408)
(NASA-CR-137) OTS Prices: HC $3.00/MF $1.00

Studies to determine which applications of fluid amplifiers would be advantageous to NASA are reported. It was concluded that the best applications for further study are as follows: (1) replacement of electronic amplifiers and networks of gas servos for engine actuation; and (2) a digital integrator that forms the fundamental building block for nearly all digital computation and control. Advantages of using fluid amplifiers for these applications are primarily environmental tolerance and the potential of higher reliability. A brief comparison of fluid amplifier and electronic reliability is included in this report. Since so many applications depend on the reliability advantages of fluid amplifiers, reliability has been defined as a "missing link" in the technology. Another "missing link" badly needed in this field is standardization of terminology, definitions, and data presentation. Author

**N65-12499*#** Eagle-Picher Co., Joplin, Mo. Couples Dept.
**INVESTIGATIONS LEADING TO THE DEVELOPMENT OF A PRIMARY ZINC-SILVER OXIDE BATTERY OF IMPROVED PERFORMANCE CHARACTERISTICS Summary Report No. 3, 1 Jul.–30 Sep. 1964**
Bill R. Hawkins 31 Oct. 1964 33 p refs
(Contract NAS8-5493)
(NASA-CR-59623) OTS Prices: HC $2.00/MF $0.50

Effort is being made to develop a cell design capable of limited cycle life while retaining the high rate and high density characteristics of the primary zinc–silver oxide system. A literature search was carried out with emphasis on references pertinent to improved separator systems. A preliminary design study was begun to determine more specifically the areas subject to design modification. Studies relative to optimization of the zinc plate densities over the useful range of discharge current densities were also begun. Author

**N65-12500*#** Eagle-Picher Co., Joplin, Mo. Couples Dept.
**INVESTIGATIONS LEADING TO THE DEVELOPMENT OF A PRIMARY ZINC-SILVER OXIDE BATTERY OF IMPROVED PERFORMANCE CHARACTERISTICS Final Report, 1 Jul. 1963–29 Jun. 1964**
B. R. Hawkins 31 Jul. 1964 66 p
(Contract NAS8-5493)
(NASA-CR-59627) OTS Prices: HC $3.00/MF $0.75

Studies planned under four phases have been directed toward improving the primary zinc–silver oxide cell, with emphasis on close voltage regulation and extended retention of charge. Phases of study included screening and evaluation of commercial separator materials, preliminary cell design study, evaluation of cell construction variables based upon a fractional factorial experiment, and construction and evaluation of prototype cells. The result has been an increased activated stand with no sacrifice in voltage or in voltage regulation. Author

**N65-12619*#** General Electric Co., Schenectady, N.Y. Advanced Technology Labs.
**STUDY OF USE OF AUXILIARY ELECTRODES IN SILVER CELLS Second Quarterly Report, 1 May–1 Aug. 1964**
[1964] 17 p
(Contract NAS5-3669)
(NASA-CR-59770) OTS Prices: HC $1.00/MF $0.50

The primary objective of this program is to investigate the use of auxiliary electrodes in primary and secondary silver–zinc cells and to modify commercially available silver–zinc cells for testing. Work included testing of several types of auxiliary electrodes that do not contain platinum metal catalysts for oxygen recombination, testing of a nonmagnetic auxiliary electrode containing platinum metal catalysts for hydrogen recombination, construction of a number of silver–cadmium cells with conventional auxiliary electrodes and placing six of the cells on continuous charge under voltage limiting conditions (1.52 ± 0.01 volts per cell), and designing a hydrogen combination cell for use in removing hydrogen from enclosed spaces. Author

**N65-12624*#** Alfred U., N.Y. Coll. of Ceramics
**FUEL CELL RESEARCH: AN INVESTIGATION OF NONSTEADY-STATE OPERATION Semiannual Status Report No. 1, Jun.–Dec. 1963**
T. J. Gray and A. A. Schneider 15 Jan. 1964 19 p refs
(Contract NsG-384)
(NASA-CR-59760) OTS Prices: HC $1.00/MF $0.50

Fuel-cell performance under nonequilibrium conditions, particularly under pulsed loading with varying off-load periods, is being investigated. After a review of measurement methods and results reported in the literature, an apparently overlooked aspect of fuel cells is discussed—the feasibility of using them for a fundamental study of nonequilibrium reaction kinetics. Based on this rational approach, the change in potential of several types of electrodes was studied as a function of time, using a constant current technique. The pulse loading system and the precision galvanostatic circuit developed for these measurements are described. Among the types of electrodes studied are porous nickel, platinized porous nickel, and porous nickel treated with a solution containing both platinum and palladium. This last type exhibited a marked increase in absorption and desorption time; results obtained when these electrodes were employed in a fuel cell are presented. M.P.G.

**N65-12625*#** Pennsylvania U., Philadelphia. Inst. for Direct Energy Conversion
**SOLAR COLLECTION LIMITATIONS FOR DYNAMIC CONVERTERS. SIMULATION OF SOLAR-THERMAL ENERGY CONVERSION SYSTEMS**
George L. Schrenk [1964] 32 p refs Presented at the AGARD Conf., Cannes, France, 16–20 Mar. 1964
(Grant NsG-316)
(NASA-CR-59759) OTS Prices: HC $2.00/MF $0.50

A mathematical model for analysis of actual solar collectors has been developed that allows the calculation, without making numerical approximations, of the energy flux on any arbitrarily shaped focal surface from any arbitrarily shaped collector surface. Typical results from this model are presented to show the effects of surface and orientation errors. Investigation of the interface between the collector and the heat receiver (the cavity opening) using this model indicates that this opening cannot be treated as a plane surface whose radiation is emitted according to Lambert's law. Analyses of cylindrical heat receivers coupled with typical collectors have been made using an "open cavity" Fredholm integral equation approach and the valid directional distribution. Results presented for the effects of the absorptivity and emissivity of the walls of the heat receiver and for reradiation losses and system performance differ significantly from the usual engineering estimates used in the design of solar power systems. M.P.G.

**N65-12725*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**DESIGN AND EXPERIMENTAL INVESTIGATION OF A THREE-STAGE MULTIPLE-REENTRY TURBINE**
David G. Evans Washington, NASA, Jan. 1959 33 p refs (NASA-Memo-1-16-59E) OTS Prices: HC $2.00/MF $0.50 (Declassified)

The turbine, which had a single rotor with three stages proportioned around it, was designed for the basic requirements of low weight flow and high specific work output. The results of the experimental investigation indicated that a static efficiency of 0.622 and an equivalent specific work output of 37.5 Btu per lb had been obtained at the design point. The first stage produced approximately one-half of the total turbine work output, the second stage one-third, and the third stage one-sixth; whereas the turbine was designed for an equal work division between the three stages. This was the result of a unique flow phenomenon that existed within the turbine and caused an excess pressure ratio across the first stage and a deficient pressure ratio across the third stage. It was concluded that the turbine performance was satisfactory, but improvements could have been made by certain refinements in the design, such as relocating two of the rotor-exit guide vanes and providing for a rotor labyrinth seal and a shorter chord rotor blade design. Author

**N65-12748#** General Motors Corp., Santa Barbara, Calif. GM Defense Research Labs.
**STUDY OF A THERMOPHOTOVOLTAIC CONVERTER First Quarterly Progress Report, Apr. 14–Aug. 11, 1964**
7 Aug. 1964 63 p refs *Its* Rept.-1
(Contract DA-28-043-AMC-00067(E))
(TR64-53; AD-452074)

Components for a portable thermophotovoltaic converter were investigated, experimentally and theoretically. Reflector-calorimeters were constructed for heat-balance studies, and a test of mounting procedures and techniques for cells in sets of 20 was conducted. Individual nonreflecting cells (without interference coatings) were studied for efficiency as a function of incident radiation density. Cells were shown to be more than 5.5 to 6% efficient at corresponding illumination levels of 9 to 6 watts/cm$^2$ and power output densities of 0.38 to 0.30 watts/cm$^2$. The transmission of intrinsic germanium wafers at wavelengths beyond the absorption edge was measured under high optical injection conditions. No change in transmission was observed, although a change of even 1% could have been detected. Reflectance measurements were extended to analyze the individual multiple reflections, clearly observed in samples with wedge (following modifications of the reflectance goniometer). Author

**N65-12752** Little (Arthur D.) Inc., Cambridge, Mass.
**LOW TEMPERATURE OPERATION OF BATTERIES Final Report, 15 May 1962–14 Jul. 1964**
R. A. Horne and David L. Richardson Ft. Monmouth, N.J., Army Electron. Labs. [1964] 246 p refs
(Contract DA-36-039-SC-90706)
(AD-451940)

On the basis of a comparative evaluation of the low-temperature performance of batteries, the properties of available insulating materials, estimates of the weight, cost, and volume of various auxiliary heating devices, and experimental studies of the cool-down rates of insulated battery systems, the following conclusions have been reached: (1) Present batteries are serviceable in conditions of extreme cold for very short mission lives or very low current drains. (2) For missions a few hours in length, inexpensively insulated conventional batteries should be serviceable. (3) For somewhat longer missions, auxiliary heat or superinsulation is required. (4) For long missions (in excess of 8 hours), auxiliary heat, preferably in conjunction with inexpensive insulation, is necessary. Author

**N65-12795*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**INVESTIGATION OF A 4.0-INCH-MEAN-DIAMETER FOUR-STAGE REENTRY TURBINE FOR AUXILIARY POWER DRIVES**
Robert Y. Wong, David L. Darmstadt, and Daniel E. Monroe Washington, NASA, Mar. 1960 24 p refs
(NASA-TM-X-152) OTS Prices: HC $1.00/MF $0.50 (Declassified)

The results indicated that at design equivalent speed and design pressure ratio (55.66), the equivalent specific work output in air was 35.95 Btu per pound at a total-to-static efficiency of 0.432. An analysis of the subject turbine indicated that partial admission and mass-flow deficits due to rotor pumping and seal leakage have an important effect on the overall efficiency of this turbine. In this analysis a theoretical efficiency of 0.519 was computed. The difference between the experimental and analytical efficiency may be attributed to the effects of mismatch in stator areas between the third and fourth stages, mixing losses due to the effects of the relatively large trailing-edge thicknesses used, and seal-leakage flows. Author

**N65-12873#** Joint Publications Research Service, Washington, D.C.
**SYNTHESIS OF CIRCUITS CONSTRUCTED ON PNEUMATIC SWITCHES**
S. A. Korovlev 10 Dec. 1964 7 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Belorussk. SSR (Minsk), v. 8, no. 8, Aug. 1964 p 501–504
(JPRS-27783; TT-64-51908) OTS: $1.00

Pneumatic (fluid amplifier) elements are diagramed, and canonical tables of Boolean functions are constructed from which schematic diagrams can be drawn. Two methods of constructing canonical tables are given, and several examples are presented. D.E.W.

**N65-12963#** AiResearch Mfg. Co., Phoenix, Ariz.
**SNAP 50/SPUR POWER SYSTEM Quarterly Technical Progress Report, 1 Aug.–31 Oct. 1964**
J. H. Dannan [1964] 100 p
(Contract AF 33(615)-1551)
(APS-5090-R3; AD-451392)

Progress in the development of the power conversion system components is presented in the following areas: "Materials

Development"; "Bearing Development"; "Turbine Development"; "Generator Development"; "Heat-Transfer Development"; and "Controls Analysis." G.G.

N65-13072# Gulton Industries, Inc., Metuchen, N.J. Alkaline Battery Div.
**INVESTIGATION OF HERMETICALLY SEALED, MAINTENANCE FREE, HIGH RATE, NICKEL-CADMIUM BATTERIES FOR AIRCRAFT APPLICATIONS Quarterly Technical Progress Report**
E. Kantner, W. Lescheck, S. Jaffe, and R. C. Shair Nov. 1964 37 p
(Contract AF 33(615)-2087)
(QTPR-1; AD-608662)

An MS-24498 battery was subjected to high rate discharges at room temperature and at -22° F, to determine what factors are responsible for the high voltage loss. Polarization was found to be the major factor. Sintered plaques of 0.020 in., 0.035 in., and 0.050 in. thickness were impregnated and formed in preparation for cell assembly. High-purity nickel and cadmium salt solutions were prepared. The VO-6 cells, containing Adhydrodes, were overcharged at sufficiently high currents to maintain internal cell pressures ranging from 5 to 65 psi. The Adhydrode power output, as a function of Adhydrode-to-cathode load resistance at these various pressures, was determined. The $Cd/Cd(OH)_2$ coulometers were fabricated for studying their voltage characteristics. Author

N65-13084# General Motors Corp., Anderson, Ind. Delco-Remy Div.
**SILVER ZINC SECONDARY BATTERY INVESTIGATION Second Quarterly Technical Progress Report, 1 Oct. 1962–1 Jan. 1963**
J. J. Lander and J. A. Keralla 2 Jan. 1963 32 p
(Contract AF 33(657)-8943)
(AD-294358)

Three 25-ampere-hour cells constructed with positive plates to which 1% palladium was added by impregnation with a palladium salt have completed 950 cycles of operation on the monovalent voltage level. Hydrogen absorption by palladium-treated silver positive plates is significantly higher than the standard silver plate by a ratio of 3 to 1 at 25° C and almost 20 to 1 at 66° C. Silver-particle size effects show relatively little difference in effect on capacity, silver deposition in separators, and cycle life after 500 cycles. Expander studies show that 16% polyethylene oxide and 2% PVA extend the cycle life of cells on the average to 950 cycles at 25% depth of discharge in the sealed condition. Hydrogen evolution studies indicate that a 2% to 4% HgO addition to the negative material, operating in 45% KOH unsaturated (ZnO) produces the least amount of gas in a 30-day period. Author

N65-13095*# Thompson Ramo Wooldridge, Inc., Cleveland, Ohio. TRW Equipment Labs.
**SUNFLOWER POWER SYSTEM TEST REPORT Topical Report, Nov.–19 Dec. 1962**
J. A. Heller Oct. 1964 100 p refs
(Contract NAS5-462)
(NASA-CR-54174; ER-5396A) OTS Prices: HC $3.00/MF $0.75

The Sunflower PCS I-1 system, which was composed of the preprototype hardware of each major component, was assembled and tested to determine component compatibility and system performance. The component integration was consistent with the flight specification of operating the condenser in a condensing direction opposing the gravitational field. Testing was augmented by auxiliary facilities for startup and steady-state operation as required. The program consisted of three separate tests that included 12 individual system startups and a total accumulated operational time of 47 hours. Testing confirmed the integration of the preprototype components and their ability to operate in a system fashion. However, operation was characterized by sensitivity of the condenser to the operating conditions. The condenser performance was aggravated by a condition of tube wetting and the influence of liquid leakage into the condenser inlet through the turbomachinery seals. Author

N65-13105# Atomics International, Canoga Park, Calif.
**SNAP CRITICAL ASSEMBLY-4B. PHASE III: WATER IMMERSION EXPERIMENTS**
S. Yee 1 Dec. 1964 115 p refs
(Contract AT(11-1)-Gen-8)
(NAA-SR-9871) OTS: $2.25

These experiments demonstrate conclusively the effectiveness of a void-poison sleeve (shipping sleeve) in maintaining a bare core subcritical when it is internally flooded and fully reflected with water; and void-poison filler blocks in maintaining a beryllium-reflected core subcritical when it is submerged in but not internally flooded with water. Experimental data were provided in support of the subsequent SNAPTRAN 10A/2-3 destruct experiment. Author

N65-13144*# Cook Electric Co., Morton Grove, Ill. Tech-Center Div.
**EFFECT OF BIOLOGICAL STERILIZATION AND VACUUM ON CERTAIN PARACHUTE RETARDATION SYSTEM COMPONENTS Final Report**
Arthur R. Anderson Aug. 1964 56 p refs *Its* Rept.-4324
(JPL-BE-4-229753)
(NASA-CR-59860) OTS Prices: HC $3.00/MF $0.50

The effects of sterilization and vacuum on four candidate parachute materials (nylon, Nomex, dacron, and silk) and two pyrotechnic components (pressure generators and reefing cutters) were investigated to evaluate their use in retardation systems for payloads being delivered on other planets. Results indicate the following: (1) Silk is completely degraded. (2) Thermal sterilization degrades and seriously stiffens nylon. (3) Average strength losses of dacron from both sterilization and vacuum do not exceed 20%, making it a promising material. (4) Average strength losses of Nomex from both sterilization and vacuum do not exceed 5%, but large variations in break strength were noted probably as an effect of the weave. (5) Folding and twisting or compacting have negligible effects, but an average strength degradation of 10% due to sewing was noted. (6) Thermal sterilization of pressure cartridges leads to a decrease in time to peak pressure and an increase in pressure generated, but vacuum has no effect on hermetically sealed cartridges. (7) Reefing cutters are available that can withstand sterilization and vacuum environments. M.P.G.

N65-13146*# Pennsylvania U., Philadelphia. Electrochemistry Lab.
**STUDIES OF THE FUNDAMENTAL CHEMISTRY, PROPERTIES, AND BEHAVIOR OF FUEL CELLS Semiannual Progress Report, 1 Mar.–30 Sep. 1964**
John O'M. Bockris [1964] 68 p refs
(Grant NsG-325)
(NASA-CR-59850) OTS Prices: HC $3.00/MF $0.75

The radioactive tracer method for investigation of adsorption was used to measure the potentials of zero charge of three metals—platinum in acid solutions, gold, and silver. A theoretical analysis is presented of the potential sweep method, essentially an extension of polarographic techniques, in which the potential of a system is controlled externally and is made to vary at a constant rate. The hydrogen evolution reaction was studied to determine the effect of the orientation of grains on the rate of simple catalytic electrode reactions. The catalytic activity for the hydrogen reaction of various metals was determined in alkaline solution. The deactivation of electrodes by oxygen reduction and by capacitance measurement was investigated. Transient behavior and the meniscus heating effect of a model porous electrode are discussed. An ellipsometric study of oxide formation on a platinum catalyst surface is reported. D.E.W.

**N65-13148*#** Naval Ammunition Depot, Crane, Ind.
**SPACE CELL TEST PROGRAM Monthly Progress Report, Period Ending 30 Sep. 1964**
E. R. Pettebone [1964] 96 p
(NASA Order W-11-252B)
(NASA-CR-59861) OTS Prices: HC $3.00/MF $0.75

The current results obtained from life cycle tests of 98 space-cell packs (50 10-cell packs and 48 5-cell packs) are presented. Test parameters include (1) ambient temperatures (0°, 25°, and 40° C); (2) depths of discharge (15% to 50% depending on length of orbit and temperature); (3) orbit times (90 min, 3 hours, and 24 hours); and (4) voltage limits per pack on charge (1.55 ±0.03 to 1.97 ±0.03 volts per cell depending on temperature). Data sheets are included showing end-of-discharge and end-of-charge voltage readings for each cell on each cycle recorded. P.V.E.

**N65-13149*#** Naval Ammunition Depot, Crane, Ind.
**SPACE CELL TEST PROGRAM Monthly Progress Report, Period Ending 31 Oct. 1964**
E. R. Pettebone [1964] 96 p
(NASA Order W-112528)
(NASA-CR-59862) OTS Prices: HC $3.00/MF $0.75

Tests of candidate cells for space power supplies are reported. Cell types subjected to life cycle tests included nickel–cadmium 10-cell packs, silver–cadmium 10-cell packs, nickel–cadmium 5-cell packs, and silver–zinc 5-cell packs. Cell failures are listed, failure analyses are presented, capacity tests are described, and data sheets are included. D.E.W.

**N65-13187#** Royal Industries, Inc., Pasadena, Calif.
**THE CESIUM-137 POWER PROGRAM Final Report, Jan. 1961–Apr. 1963**
Hampden O. Banks, Jr. May 1964 225 p refs
(Contract AT(04-3)-366)
(RRC-0104; SAN-366-1) OTS: $3.00

The program objective was the design and fabrication of a thermoelectric generator, powered by cesium-137, and capable of safely providing uninterrupted power in the 5 W range to an undersea seismic station. The generator developed was not capable of delivering 5 watts; a maximum of 2.75 watts was achieved. However, all other design objectives were met, including the following: (1) A chemical fuel form, cesium borosilicate was developed that rendered radiocesium virtually inert to leaching and that may be cast in any form. (2) Process parameters for the fuel formulation were established. (3) A full-scale model of a cesium generator was delivered. (4) A radiation shield was designed using depleted uranium, which offered attractive size and weight savings. (5) The task of replating the fully fueled (26 000 curies) uranium core was accomplished. (6) The overall generator size and weight came well within design specifications. (7) A lightweight pressure shell for the generator proper was developed capable of withstanding ocean pressures to 36 000 feet depth. (8) A thermoelectric module suitable for incorporation into the generator was developed. (9) A safety analysis was prepared. D.S.G.

**N65-13221*#** Fairchild Camera and Instrument Corp., Syosset, N.Y. Fairchild Space and Defense Systems Div.
**[PHOTOGRAMMETRIC AND PHOTOMETRIC OBJECTIVES AND CAPABILITIES OF THE SURVEYOR LANDER TV EXPERIMENT] Final Report**
30 Dec. 1963 162 p refs
(JPL-950665)
(NASA-CR-59879; SME-BA-130) OTS Prices: HC $5.00/MF $1.00

Detailed scientific objectives for the Surveyor Lander TV Experiment are discussed in terms of photogrammetry, photometry, and colorimetry. The mission of the Surveyor Lander S/C is the soft landing of a package of scientific instruments on the lunar surface in an effort to determine some of its basic properties. The local spatial brightness and color characteristics of the lunar surface are to be established by the Surveyor S/C survey television subsystem, whose primary requirements are established for geometric fidelity, photometry and colorimetry. The design features, calibration objectives, and operation considerations of the TV subsystem are discussed. R.L.K.

**N65-13222*#** Allis-Chalmers Mfg. Co., Milwaukee, Wis. Research Div.
**RESEARCH AND DEVELOPMENT OF AN OPEN-CYCLE FUEL CELL SYSTEM Summary Report, 1 Jan.–31 Aug. 1964**
J. Ward, J. Euclide, R. Desai, and D. Ghere 30 Sep. 1964 121 p
(Contract NAS8-2696)
(NASA-CR-59894; NAS-8-2696-SR-001) OTS Prices: HC $4.00/MF $1.00

Verification tests were conducted on the static moisture-removal system, and various operating parameters were determined. Operation with moisture removal from both the oxygen and hydrogen side of the fuel cell was accomplished. A mathematical model of the static moisture-removal system was made, and experimental verification was obtained by using a gas chromatograph to measure the actual water-vapor pressures within the various cell cavities. Performance tests were accomplished to determine the effects of thin electrolyte vehicles. Life tests were conducted to evaluate various plate and electrode configurations and materials to improve performance ratings. Multicell assemblies were built and tested to extend the performance data gathered from the single-cell units. In these tests series–parallel constructed fuel-cell assemblies were tested, and their performance was compared with units assembled with electrical-series connection. Thermal design studies were effected on the fuel cell system and subsystem to achieve optimum performance with minimum weight.
Author

**N65-13224*#** Stanford U., Calif. Stanford Electronics Labs.
**THE THEORY OF LARGE AMPLITUDE OSCILLATIONS IN THE ONE-DIMENSIONAL LOW PRESSURE THERMIONIC CONVERTER**
Peter Burger [1964] 23 p refs
(Grant NsG-299)
(NASA-CR-59881) OTS Prices: HC $1.00/MF $0.50

The large amplitude oscillations in a one-dimensional low-pressure thermionic converter are analyzed. With the help of results obtained from computer calculations designed to simulate

the operation of the converter, the current oscillations are explained in terms of the changing forms of the potential distribution in the system. The variations in the form of the potential function are explained by means of the concept of a temporary dc state. Such a state differs from the ideal self-consistent state in that the electrons and the potential adopt new distributions while the ion distribution stays the same as in the self-consistent state. In fact, the ions are treated as too heavy to respond to the new potentials, while the electrons adjust themselves rapidly to them. The existence of a temporary dc state is decided by solving a static problem only; but if such a state exists, then there is a possibility for relaxation type of oscillations in the system with frequencies characteristic of the ions. Author

**N65-13226#** Battelle Memorial Inst., Columbus, Ohio.
**MULTIFUELED THERMAL-ENERGY-CONVERSION SYSTEMS Final Report, 1 Jul. 1962–30 Jun. 1964**
Herbert R. Hazard [1964] 125 p refs
(Contract DA-36-039-SC-90838)
(Rept.-8; AD-450224)

CONTENTS:

1. [MINIATURE ULTRASONIC ATOMIZER DEVELOPMENT, ULTRASONIC BURNER OPERATION, AND THERMOELECTRIC-GENERATOR SIMULATOR DESIGN] p 3–9 (See N65-13227 03-03)

2. [RESEARCH TO DETERMINE THE FEASIBILITY OF UTILIZING WOOD, CHARCOAL, ANIMAL DUNG, AND OTHER FUELS TO POWER GENERATORS SUITABLE FOR PRODUCING 150 WATTS OF ELECTRIC POWER] p 11–15 refs (See N65-13228 03-03)

**N65-13227#** Battelle Memorial Inst., Columbus, Ohio.
**[MINIATURE ULTRASONIC ATOMIZER DEVELOPMENT, ULTRASONIC BURNER OPERATION, AND THERMOELECTRIC-GENERATOR SIMULATOR DESIGN]**
*In its* Multifueled Thermal-Energy-Conversion Systems [1964] p 3–9 (See N65-13226 03-03)

Results of the multifuel thermal energy converter program during the final quarter include the following: (1) Experimental evaluation of Boiler 40 was completed by running tests in which buffalo dung and green wood were burned; efficiency was measured at 53% to 55% for the former, and 41% for the latter. (2) A previous design study of a Rankine-cycle generator was reviewed and updated to include several ideas to reduce weight, and a new system weighing only 20 lbs. was designed. (3) A thermoelectric generator using germanium–silicon materials was designed on the basis of the heat fluxes measured in solid fueled simulators. (4) A miniature ultrasonic atomizer having improved performance was developed, and an ultrasonic burner was built and operated. D.S.G.

**N65-13228#** Battelle Memorial Inst., Columbus, Ohio.
**[RESEARCH TO DETERMINE THE FEASIBILITY OF UTILIZING WOOD, CHARCOAL, ANIMAL DUNG, AND OTHER FUELS TO POWER GENERATORS SUITABLE FOR PRODUCING 150 WATTS OF ELECTRIC POWER]**
*In its* Multifueled Thermal-Energy-Conversion Systems [1964] p 11–115 refs (See N65-13226 03-03)

The research included experimental studies of combustion chambers to determine burning rates, heat-absorption rates, and other design criteria; development of a boiler having satisfactory dynamic characteristics; design studies of a Rankine-cycle generator; a Stirling-cycle generator, and a thermoelectric generator; and other related studies. A feasibility study of a multifueled liquid-fuel burner suitable for fuels ranging from gasoline to No. 2 heating oil was made. Author

**N65-13310*#** Livingston Electronic Corp., Montgomeryville, Pa.
**DEVELOPMENT OF A LOW TEMPERATURE BATTERY FOR SPACE PROBE APPLICATIONS First Quarterly Report**
William F. Meyers 15 Nov. 1964 67 p
(Contract NAS3-6009)
(NASA-CR-54205) OTS Prices: HC $3.00/MF $0.75

Discussed is progress in a program aimed at obtaining 2.1-watt, 72-hour reserve battery performance over the temperature range +20° C to −73° C by modification of existing Livingston Ammonia Battery designs. Numerous difficulties associated with hermetic seals below −55° C were encountered. Cyclic load and recording systems were evolved to provide for the specified electrical requirements on a single cell and/or a five-series-cell battery basis. Thirty-three useful tests are reported that gave a preliminary coverage of the performance of $Mg/NH_3 \cdot KSCN$ cells with selected cathodes as follows: mercuric sulfate cathode—103 hours at −73° C; meta-dinitrobenzene cathode—70 hours at −55° C; and sulfur cathode—12 hours at −55° C. It is concluded that mercuric sulfate in a bobbin cell will be capable of meeting the first objective of the program. P.V.E.

# 04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; protective clothing and equipment; physiological and psychological factors. For related information see also: 05 Biotechnology.

**N65-12340#** Rochester U., N.Y.
**HAZARD TO MAN FROM I-131 IN THE ENVIRONMENT**
Richard George Cuddihy 20 Nov. 1964 75 p refs
(Contract W-7401-ENG-49)
(UR-653)

The major factors involved in the transfer of iodine-131 from the environment into the human body, its source, and the methods of minimizing the radiation hazard are discussed. The possible sources include nuclear-weapons tests, nuclear reactors, and reactor-fuel processing plants. These atmospheric releases can be followed, and their deposition can be predicted with proper meteorological information. An experiment was conducted to determine the fractional uptake of the daily ingested dose of iodine by the human thyroid gland, and safe levels of atmospheric contamination were calculated. The amounts of stable iodine to be added to the daily diet of a dairy cow and of a human being to reduce the assimilation of iodine-131 are given. Other protective measures are cited. D.S.G.

**N65-12413*#** Northrop Corp., Hawthorne, Calif. Space Labs.
**INVESTIGATION OF PEROGNATHUS AS AN EXPERIMENTAL ORGANISM FOR RESEARCH IN SPACE BIOLOGY Fourth Quarterly Progress Report, 1 Jul.–30 Sep. 1964**
J. J. Gambino and R. G. Lindberg [1964] 12 p ref
(Contract NASw-812)
(NASA-CR-59706; NSL-64-29-4) OTS Prices: HC $1.00/MF $0.50

Pocket mice underwent massive doses of gamma irradiation to determine whether they are subject to the same CNS death pattern as other mammals. The animals were lowered into a 5000 curie $Co^{60}$ source that emitted a dose rate of 5.2 krad per minute. The total dosage of irradiation was obtained by the addition of the dose received while in the source

of radiation plus the transit dose received while in the lowering and raising processes. It was found that the pocket mice are just as susceptible to high-dose irradiation as are the conventional mice. All animals receiving 13.7 and 24.1 krad exhibited ataxia and other behavioral effects immediately following exposure. Their mean survival time was 7 to 8 days. G.G.

**N65-12416*#** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
**RADIOLOGICAL SAFETY HANDBOOK**
P. V. King 1 Nov. 1964 117 p
(NASA-TM-X-54859; SP-4-41-S) OTS Prices: HC $4.00/MF $0.75

This handbook describes the organization, policy, procedures, and safety requirements for a radiological safety program. It is written as a technical supplement to safety regulations and safety plans for users of X-rays and radioactive materials. The handbook specifically defines KSC procedures and requirements for the procurement, transfer, and shipment of radioactive materials, for the handling and disposal of radioactive materials, and for personnel monitoring, doses, and emergency procedures. D.E.W.

**N65-12528#** Virginia Inst. of Marine Science, Gloucester Point.
**A MATHEMATICAL ANALYSIS OF THE DYNAMIC SOARING FLIGHT OF THE ALBATROSS WITH ECOLOGICAL INTERPRETATIONS Special Scientific Report No. 50**
Clarence D. Cone, Jr., May 1964 108 p refs Sponsored by NSF

Typically observed soaring patterns and other pertinent flight characteristics of the albatross are described. Using these observations as a basis, an idealized soaring cycle in shear layers is constructed for further analysis. The mechanics of each of the four basic phases of a cycle is investigated in detail, and the fundamental equations of motion and energy interchanges are formulated. The factors in the equations, expressed in terms of the structural and aerodynamic parameters of the albatross, are analyzed in order to find their relative importance and significance in the ecology of the bird. The combination of basic phases of the ideal cycle with various secondary flight phases to obtain almost any desired flight path is demonstrated. Important related facts in the bird's ecology are discussed in relation to the aerodynamic analyses, and land and ocean soarers are compared by ecology and by aerodynamic requirements. The mechanics of dynamic soaring in gusts is also discussed, and the correspondence to shear-layer soaring is pointed out. D.E.W.

**N65-12608*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**REPORT OF HEALTH HAZARDS SURVEY ON XS-AM-7 RADAR SYSTEM, JUNE 10–11, 1964**
Oct. 1964 15 p refs Survey performed by Controls for Radiation, Inc.
(NASA-TM-X-55110; X-600-64-306) OTS Prices: HC $1.00/MF $0.50

A survey was made to determine the rf and X-ray radiation hazards that confront the personnel of an XS-AM-7 radar system. Dosimeter measurements were taken in the calculated near-field region of the installation and around the antenna itself, to determine the power densities present, and a potential radiation hazard was found within the near field of the antenna. It was recommended that the area around the antenna be fenced in, and that the antenna be equipped with an interlock to prevent its operation at an elevation of less than + 10°. G.G.

**N65-12626#** Joint Publications Research Service, Washington, D.C.
**PROTECTION AGAINST RADIATION AND DOSIMETRY**
25 Nov. 1964 62 p Transl. into ENGLISH of 3 chapters from the book "Kratkiy Spravochnik po Radiatsionnoy Zashchite i Dozimetrii" Moscow, Atomizdat, 1964
(JPRS-27535; TT-64-51784) OTS: $3.00

CONTENTS:
1. RADIATION FROM NATURAL SOURCES p 1–35 (See N65-12627 03-04)
2. RADIATION DOSAGES FOR VARIOUS HUMAN ORGANS AND TISSUES p 36–43 (See N65-12628 03-04)
3. CONTENT OF CERTAIN STABLE ELEMENTS WITHIN OBJECTS IN THE ENVIRONMENT AND IN THE HUMAN ORGANISM p 44–58 (See N65-12629 03-04)

**N65-12627#** Joint Publications Research Service, Washington, D.C.
**RADIATION FROM NATURAL SOURCES**
*In its* Protect. Against Radiation and Dosimetry 25 Nov. 1964 p 1–35 (See N65-12626 03-04) OTS: $3.00

Radiation from natural sources is divided into cosmic radiation and natural environmental radioactivity. Cosmic radiation and tissue dosages from this source are discussed very briefly. Naturally occurring radioactive isotopes are tabulated with their physical and radiological characteristics, and tables are given of alpha, beta, and gamma emitters of the uranium and thorium series. Characteristics of potassium 40, carbon 14, tritium, and radium 226 are discussed. Natural radon 222 and radon 220 in the lower atmospheric layers are reviewed by geographic location and activity. The natural radioactivity in plants and in food products, caused by potassium 40 or by radium, is treated at length, and the radioactivity of the human body and of various organs is given in tables. D.E.W.

**N65-12628#** Joint Publications Research Service, Washington, D.C.
**RADIATION DOSAGES FOR VARIOUS HUMAN ORGANS AND TISSUES**
*In its* Protect. Against Radiation and Dosimetry 25 Nov. 1964 p 36–43 (See N65-12626 03-04) OTS: $3.00

General data on the doses of natural radioactive isotopes contained in rock, soil, air, and the human organism are presented in terms of their effects on man. Radiation doses encountered by man in X-ray therapy and X-ray diagnosis are also given. The information is presented as tables. D.E.W.

**N65-12629#** Joint Publications Research Service, Washington, D.C.
**CONTENT OF CERTAIN STABLE ELEMENTS WITHIN OBJECTS IN THE ENVIRONMENT AND IN THE HUMAN ORGANISM**
*In its* Protect. Against Radiation and Dosimetry 25 Nov. 1964 p 44–58 (See N65-12626 03-04) OTS: $3.00

Tables are given of the chemical compositions and the concentrations of various elements present in the U.S.S.R. in atmospheric precipitation, river waters, soils, various lake waters, green plants, food products, fruits and vegetables, cereal crops from various regions, wheat, milk, and human organs and tissues. D.E.W.

**N65-12731#** Innsbruck U. (Austria). Inst. of Experimental Psychology
**COLOR DISCRIMINATION WITHOUT CHROMATIC VISION First Quarterly Technical Status Report, 1 Jul.–30 Sep. 1964**

Anton Hajos 1 Oct. 1964 13 p ref
(Contract DA-91-591-EUC-3325)
(Rept.-1)

The division between the adaptation to artificial chromatic distortions and the adaptation to the natural defects of the eye is presented. The possibility of gaining information from such defects is discussed. G.G.

**N65-12732#** Joint Publications Research Service, Washington, D.C.
**STUDIES IN RADIOTELEMETRY IN PHYSIOLOGY AND MEDICINE**
30 Nov. 1964 14 p Transl. into ENGLISH of 3 monographs "Radiotelemetriya v Fiziologii i Meditsine" Sverdlovsk, 1963 p 10–13, 27–30, 40–44
(JPRS-27600; TT-64-51826) OTS: $1.00

CONTENTS:

1. BIOTELEMETRIC SYSTEMS IN COSMONAUTICS I. T. Akulinichev, R. M. Bayevskiy, V. G. Denisov, and V. I. Yazdovskiy p 1–4 (See N65-12733 03-04)

2. THE SYSTEM OF PHYSIOLOGICAL MEASUREMENTS ON THE SPACESHIPS VOSTOK 5 AND VOSTOK 6 I. T. Akulinichev, R. M. Bayevskiy, A. Ye. Baykov, K. P. Zazykin, L. G. Maksimov et al p 5–8 (See N65-12734 03-04)

3. TELEMETRIC SYSTEMS WITH SUCCESSIVE TRANSMISSION OF DATA E. F. Ovchinnikov, I. T. Akulinichev, R. M. Bayevskiy, A. A. Belyayev, and I. S. Shadrintsev p 9–12 (See N65-12735 03-04)

**N65-12733#** Joint Publications Research Service, Washington, D.C.
**BIOTELEMETRIC SYSTEMS IN COSMONAUTICS**
I. T. Akulinichev, R. M. Bayevskiy, V. G. Denisov, and V. I. Yazdovskiy *In its* Studies in Radiotelemetry in Physiol. and Med. 30 Nov. 1964 p 1–4 (See N65-12732 03-04) OTS: $1.00

The biological telemetry sensors of the physiological and hygienic parameters recorded during the space flights of Soviet spaceships and satellites are listed. These measurements were supplemented by television observation, radio communication, and the monitoring of a number of physical parameters, especially the level of cosmic radiation. G.G.

**N65-12734#** Joint Publications Research Service, Washington, D.C.
**THE SYSTEM OF PHYSIOLOGICAL MEASUREMENTS ON THE SPACESHIPS VOSTOK 5 AND VOSTOK 6**
I. T. Akulinichev, R. M. Bayevskiy, A. Ye. Baykov, K. P. Zazykin, L. G. Maksimov et al *In its* Studies in Radiotelemetry in Physiol. and Med. 30 Nov. 1964 p 5–8 (See N65-12732 03-04) OTS: $1.00

Physiological measurements during space flight are obtained to insure the flight safety and to carry out a program of medicobiological investigations in outer space. A block diagram of the physiological measurement system in the two Vostok spaceships is presented. Through the onboard radiotelemetric devices the following physiological parameters were transmitted: electrocardiograms, pneumatograms, electroencephalograms, electro-oculograms, seismocardiograms, and galvanic skin reactions. G.G.

**N65-12735#** Joint Publications Research Service, Washington, D.C.
**TELEMETRIC SYSTEMS WITH SUCCESSIVE TRANSMISSION OF DATA**
E. F. Ovchinnikov, I. T. Akulinichev, R. M. Bayevskiy, A. A. Belyayev, and I. S. Shadrintsev *In its* Studies in Radiotelemetry in Physiol. and Med. 30 Nov. 1964 p 9–12 (See N65-12732 03-04) OTS: $1.00

This is a description of a multichannel biotelemetric system for monitoring the pulse rate, the respiration rate, and the mechanical activity of the heart and other motor activities. The system includes sensors and electrodes, amplifying and measuring devices, an electronic commutator, and a transmitter involving a quartz stabilization with a frequency of 200 kc. It is felt that the field of biological telemetry should eventually include a remote-control consecutive program recording. G.G.

**N65-12770#** Joint Publications Research Service, Washington, D.C.
**REACTION TIME OF MAN**
Ye. I. Boyko 16 Dec. 1964 86 p refs Transl. into ENGLISH of the book "Vremya Reaktsii Cheloveka" Moscow, "Meditsina" Publishing House, 1964, p 73–106, 387–399, 400–416, 417–436, 437–438
(JPRS-27879; TT-64-51954) OTS: $3.00

The first article discusses the fallacy of depicting human response as a simple reflex, i.e., as a one-track direction of the excitatory process from a single direct signal to the organs of action. The interaction of the verbal signal (the so-called second signal) with the direct signal is analyzed by considering different forms of simple and complicated reactions within the framework of Pavlovian doctrine. According to Pavlov, the "reasoned act" resulting from verbal and nonconcrete thinking is regulated by the second signal. The implications of this fact are discussed in relation to measurements of reaction time in man. The second article consists of a review and discussion of literature concerning reaction time as a laboratory indicator in practical psychological and physiological research applications. A tabular summary of neurochronometrical data by function, time, and data source is appended. M.P.G.

**N65-12782#** California U., Berkeley. Sanitary Engineering Research Lab.
**HARVESTING AND PROCESSING SEWAGE-GROWN PLANKTONIC ALGAE**
C. G. Golueke, W. J. Oswald, and H. K. Gee Sep. 1964 61 p refs (SERL-64-8)

Results of an intensive investigation of the economical harvesting of sewage-grown algae indicate that three steps are required: (1) initial concentration; (2) dewatering or secondary concentration; and (3) final drying. Chemical precipitation and centrifugation were found to be most promising for the first step; however, economically, centrifugation is a borderline operation because of power requirements and capitalization costs. Dewatering using a 12-inch solid-bowl centrifuge precoated with lime was the most satisfactory, followed by final drying of a thin algae film on a heated drum. Such drying minimizes loss of labile nutrients, improves digestibility, and produces an essentially sterile product. Sand-bed drying in open air is also a satisfactory low-cost method. Several other very effective processes for all three operations are discussed, but these were judged prohibitive in cost. The entire question of the economics of the process resolves itself into whether or not there will be a durable and lucrative market for sewage-grown algae and upon the value that can be placed on the purified water produced as a byproduct. M.P.G.

**N65-12783#** Joint Publications Research Service, Washington, D.C.
**AUTOMATION PROBLEMS IN BIOPHYSICS**
V. I. Krinskiy et al 10 Dec. 1964 32 p refs Transl. into ENGLISH from Biofizika (Moscow), v. 9, no. 4, 1964 p 484–499, 522–523
(JPRS-27785; TT-64-51910) OTS: $2.00

The following papers are presented: "Asymptotically Optimal Automatic Devices with Exponential Field of Conversion"; "The Problem of the Spinal Regulation of Motor Activity"; "Reactivity Mechanisms of the Waves of a Rhythmic Electroretinogram during the Aftereffect of a Continuous Light"; and "Model of an Electrically Excited Membrane System." D.E.W.

**N65-12830#** California U., Berkeley. Lawrence Radiation Lab.
**HEALTH CHEMISTRY PROCEDURES FOR RADIOISOTOPE SAFETY**
13 Oct. 1964 102 p
(Contract W-7405-ENG-48)
(UCRL-11700) OTS: $4.00

Presented are the following topics: "Organization for Radiation Safety at LRL-Berkeley"; "Administration of Contractual Safety Obligations"; "Procedures Governing the Use of Radioactivity"; and "Radiation Incidents." G.G.

**N65-12840#** Institute for Research, State College, Pa.
**BEHAVIORAL BIOPHYSICS**
Allan H. Frey Apr. 1964 33 p refs
(Contracts Nonr-3303(00); Nonr-4169(00))
(Rept.-64-01; AD-606961)

This paper is an analytical review, primarily of foreign data, with emphasis upon those relevant to the nervous system and behavior. Papers are reviewed in six groups—sensory effects, conditioning, activity, cortical, subcortical, and morphological effects. The implications of the data are discussed, and several lines of investigation are suggested. Author

**N65-12843#** Flying Personnel Research Committee (Gt. Brit.)
**THE EFFECT OF IMMERSION ON MEAN INTRAPULMONARY PRESSURE**
A. S. Jarrett Nov. 1963 14 p refs
(FPRC/1220)

The pressure–volume relaxation curves for the chest were determined for the vertical and horizontal positions in air and water. The mean intrapulmonary pressure was shown to increase by 19-cm $H_2O$ in the vertical position, and 7-cm $H_2O$ in the supine position in water, both measured relative to the depth of the sternal notch. The concepts of centroid and eupneic point are discussed, and shown to coincide under appropriate conditions. The optimal positioning of a diver's demand regulator is discussed. Author

**N65-12870#** Joint Publications Research Service, Washington, D.C.
**CONFERENCE ON THE INTERNATIONAL YEAR OF THE QUIET SUN**
S. V. Vladimirov 27 Nov. 1964 5 p Transl. into ENGLISH from Priroda (Moscow), no. 9, 1964 p 113–114
(JPRS-27563; TT-64-51811) OTS: $1.00

A conference devoted to the organization of medico–biological observations during the International Year of the Quiet Sun (1964–1965) was held May 18 and 19, 1964, at the Institute of Therapy, Academy of Medical Sciences U.S.S.R. The following subjects were discussed; planetwide variations in meteorological and other geophysical fields, and their manifestations in the biosphere; the effect of rhythmic and cyclic solar activity on organic terrestrial life; the biological action of electromagnetic fields, both natural and artificial; and the effect of heliogeographic factors on the cardiovascular system, as studied during the period of the International Geophysical and Geodetic Union. Author

**N65-12874#** Joint Publications Research Service, Washington, D.C.
**ELECTROPHYSIOLOGICAL INVESTIGATIONS OF THE NATURE OF STANDING IN MAN**
A. A. Oganisyan 15 Dec. 1964 28 p refs Transl. into ENGLISH from the book "Mekhanizmy Kompensatornykh Prisposobleniy" Moscow, Acad. of Sci. USSR, 1964 p 50–61
(JPRS-27841; TT-64-51935) OTS: $2.00

The natural electromyogram and the integrated activity of the antigravitation muscles of the legs in the position of standing at rest were studied in children, adults, and invalids with legs amputated at the thigh. Among the conclusions drawn from this study are the following: (1) The electrical activity of the quadriceps muscle was minimal or absent in the majority of healthy subjects standing on both legs or on one leg; in the few where electrical activity was observed, the lateral head of the muscle was more active than the rectus femoris. (2) During standing on both legs, the common center of gravity of the body varied little; during standing on one leg, the correction of equilibrium is effected predominantly by the shin muscles. (3) Only acute and significant displacement of the center of gravity evokes activity of the antigravity muscles. (4) Holding heavy objects in the hands did not cause or intensify activity of the antigravity muscles. Results for amputees and polio victims are also presented. M.P.G.

**N65-12875#** Joint Publications Research Service, Washington, D.C.
**A HUMAN IN A SPACESHIP**
L. Markelova, D. Dmitriyev, and L. Bernaskoni 16 Dec. 1964 10 p Transl. into ENGLISH from Sov. Litva (Vil'nyus), 4 Nov. 1964 p 3–4
(JPRS-27880; TT-64-51955) OTS: $1.00

Experience gained from the Voskhod three-man spaceflight is incorporated in a popular review of possible solutions to problems of passenger-carrying spaceships. Life-support-system modifications, radiation protection, and biological compatibility are discussed. M.P.G.

**N65-12897#** Flying Personnel Research Committee (Gt. Brit.)
**DESIGN CONSIDERATIONS IN WHOLE BODY PLETHYSMOGRAPHY**
A. S. Jarrett and D. Denison Airmin., Jul. 1963 11 p refs
(FPRC/Memo-204)

The Institute of Aviation Medicine whole body plethysmograph showed paradoxical pressure changes with a subject inside. These were shown to apply to any plethysmograph, but were only apparent in an instrument made of an insulating material. It is concluded that, ideally, a plethysmograph should be constructed of highly conductive material and should be of a shape that allows easy ventilation between experiments. Author

**N65-12931#** Joint Publications Research Service, Washington, D.C.
**MEDICINE IN ORBIT**

Mikhail Novikov 16 Dec. 1964 6 p Transl. into ENGLISH from Trud (Moscow), 15 Oct. 1964 p 2
(JPRS-27-883; TT-64-51957) OTS: $1.00

This article presents an overall view of the role of the physician in space medicine. His duties start with his participation in the selection of the cosmonauts, followed by observations and supervision of their physical and mental processes during training. He takes part in the planning and building of the spacecraft and in the selection of trajectories, and will be needed as participating member during prolonged space flights. G.G.

N65-12939# Hanford Atomic Products Operation, Richland, Wash. Physics and Instrument Lab.
**PROGRESS IN RADIOLOGICAL PHYSICS: A SUMMARY OF HANFORD LABORATORIES ACHIEVEMENTS IN THESE PROGRAMS UNDER GENERAL ELECTRIC, 1947–1964**
W. C. Roesch Sep. 1964 87 p refs
(Contract AT(45-1)-1350)
(HW-83605) OTS: $3.00

The fields of study covered are whole-body counting, neutron dosimetry, theoretical dosimetry, radiation calorimetry, gamma-ray dosimetry, beta-ray dosimetry, accident dosimetry, radiation damage in graphite, and gonadal radiation. R.L.K.

N65-12958# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio. Biomedical Lab.
**RESPIRATORY AND MICROCLIMATE TEMPERATURES WITHIN THE PARKA HOOD IN EXTREME COLD Final Report**
James H. Veghte Sep. 1964 12 p refs
(AMRL-TDR-64-79; AD-608139)

The standard Air Force arctic clothing was worn to determine if it provided adequate head protection in extremely cold temperatures. Subjects were exposed to −62° C for 40 to 50 minutes in an environmental chamber. Possible respiratory problems and frostbite of the cheeks and nose were the primary concern. Subjects resting or exercising experienced no respiratory or frostbite problems. Air in the hood rapidly approached ambient conditions, because of the expulsive nature of expiration and the strong convective air movement. Exercise increased the microclimate temperatures in the hood. The existing hood design was found to provide adequate head protection for AF personnel at more extreme temperatures than are normally encountered in the Arctic. Author

N65-13111# Naval Medical Research Lab., New London, Conn.
**EXERCISE TOLERANCE STUDIES IN AN ARTIFICIAL ATMOSPHERE UNDER INCREASED BAROMETRIC PRESSURE**
John I. Lynch 2 Jan. 1964 22 p refs
(Rept.-419; AD-449531)

A study was made to determine the ability of human subjects to do exercise while living under pressure equivalent to 200 feet of sea water and to record the cardiovascular reactions of the subjects of this exercise. In terms of work potential and work tolerance, no decrement in performance was found during a period of 10-days' confinement of three men at 7 atmospheres of pressure. The indication of detrimental effect as noted in the cardiovascular scores in the "step-up" test appears to be due to the problem of carbon dioxide accumulation and the difficulty in reducing its concentration in a closed atmosphere. D.S.G.

N65-13117# Gt. Brit. Dept. of Scientific and Industrial Research. Warren Spring Lab.
**HUMAN SCIENCES IN INDUSTRY (ANNOTATED BIBLIOGRAPHY). PART I: ERGONOMICS**
Oct. 1964 137 p refs

This is a bibliography of papers pertaining to biotechnology in industry. Among the subjects presented are human factors, psychological concepts, the effects of alcohol, environmental effects, and behavioral observations. G.G.

N65-13172# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
**A STUDY OF THE ACOUSTIC REFLEX IN INFANTRYMEN**
Michael H. L. Hecker and Karl D. Kryter 1 Oct. 1964 30 p refs
(Contract DA-49-007-MD-985)
(Rept.-1159; AD-449855)

The degree of reflex response to monaurally presented white noise (100 dB SPL) was measured and graphically recorded at the contralateral ear for 40 career infantrymen with an acoustic bridge. These soldiers had been exposed to controlled amounts of weapon noise, and preexposure and postexposure audiograms were obtained. The results show that subjects with a high-preexposure HL are less susceptible to TTS than subjects with normal hearing. The results further indicate that a strong acoustic reflex is associated with high rather than low preexposure HL for subjects having no appreciable conductive hearing impairment. Subjects with suspected middle-ear disorders exhibited no reflex response to the same stimulus. Author

N65-13205# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
**TRANSMISSION AND CODING OF INFORMATION IN AUDITORY NERVOUS SYSTEM Final Report, 8 Jan. 1962–14 Feb. 1964**
W. D. Neff [1964] 55 p refs *Its* Rept.-1127
(Contract AF 49(638)-1142)
(AFOSR-64-0966; AD-600222) OTS: $5.60

Summarized are studies made of the changes that occur in neural activity during learning and during different stages of alertness and sleep. Responses evoked from the auditory system of cats during conditioning to an acoustic signal have been measured by means of electrodes implanted in the inferior colliculi and on the auditory cortex. It is concluded that the changes observed in the evoked response are not to be taken as neural correlates of learning. Results of studies of "EEG Responses to Auditory Stimuli During Sleep," "Cortical Responses after Transection of the Brachium of the Inferior Colliculus and Adjacent Pathways," and "Evoked Potentials in Neocortex of Unanesthetized Opossum" are presented in three appendixes. P.V.E.

N65-13216# Virginia U., Charlottesville.
**A SURVEY OF CHRONIC WEIGHTLESSNESS SIMULATION IN BIOLOGICAL RESEARCH**
[1964] 114 p refs
(Contract AF 18(600)-2057)
(HQARSC-TDR-64-1; AD-607052) OTS: $2.75

The experimental simulation of weightlessness by prolonged, quiet bed rest, by water flotation, and by body and/or limb immobilization is evaluated. The value of the simulation of a low-gravity environment by immobilization was found questionable because it produces the type of low activity characterized by reduced external motion, whereas a true weightlessness environment would not necessarily prevent

external motion and might even permit greater amounts of such motions. It was found that studies of immobilization can be related to the restrictions that are imposed by the size of the existing space capsules, but should not be used to predict the effect of true weightlessness. G.G.

**N65-13333#** Dow Chemical Co., Denver, Colo. Rocky Flats Div.
**A STUDY OF TWO COMMERCIAL FILM BADGE SERVICES**
J. R. Mann 21 Dec. 1964 12 p
Contract AT(29-1)-1106)
(RFP-451) OTS: $0.50

The services of two commercial film-badge processors were purchased for a 3-month trial period. Fifty badges from each company were exchanged every two weeks. Each badge contained a beta–gamma and a nuclear track film. Each supplier stamped the date and a code number on each film wrapper. The user was required to change the film in the badges every two weeks and ship the used film back to the supplier for processing and evaluation. Results were then received an average of 18.5 days after the film was returned. The average of the dose results for beta–gamma radiation for Company A was 2.7 times higher than the Dow badge, while for Company B the average was 0.77 of the dose measured with the Dow badge. Both companies were lower than Dow on average neutron dose—Company A by a factor of 2, Company B by a factor of 40. Author

# 05 BIOTECHNOLOGY

Includes life support systems, human engineering, crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

**N65-12490#** Air Force Dept., Washington, D.C.
**GUIDED MISSILES FUNDAMENTALS (MANUAL)**
15 Jan. 1964 582 p Supersedes AFM-52-31, 20 Sep. 1957
(AFM-52-31)

This manual provides personnel in the missile-electronic-maintenance career field and missile-operations utilization field with reference information on the fundamentals of guided missiles. It also provides a basic coverage of the subject for students in these and closely associated career and utilization fields. A prerequisite to the understanding of these fundamentals is a knowledge of electronic principles. Author

**N65-12491#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering
**A MODEL OF THE INTRA-AURAL REFLEX**
Stephen Barclay Place (M.S. Thesis) Jun. 1964 25 p refs
(GGC/EE/64-15; AD-603955)

The response of the intra-aural reflex to audiofrequency sounds with defined amplitude envelopes was measured and recorded. Based upon these data, as well as upon a block diagram consideration of the linear and nonlinear physiological aspects of the intra-aural reflex, an analog computer circuit was developed to model the reflex. The model was subjected to the same stimulus shapes, and the response was recorded. Comparison of the response of the reflex and the response of the model revealed a high degree of correlation, and validated the choice of building blocks used for the simulation. Author

**N65-12535#** Naval Ordnance Test Station, China Lake, Calif. Aviation Ordnance Dept.
**VISUAL SEARCH FOR TARGETS: LABORATORY EXPERIMENTS**
Ronald A. Erickson Oct. 1964 45 p
(NAVWEPS-8406; NOTS-TP-3328; AD-448468)

In laboratory experiments, visual search performance of 16 male subjects was measured and related to display- and observer-dependent parameters. Several facts emerged. A significant correlation exists between peripheral visual acuity scores and search-time scores for a search task in a static field. This correlation is dependent upon the angle of the visual axis at which acuity is measured and the number of objects in the field being searched. When the field is moving with respect to the subject, search performance decreases when the velocity of the field increases. Comparison of data from the static search experiment with that from the dynamic experiment indicates that this performance degradation is due to a time limitation and not to motion per se. Further, with velocity increase, foveal acuity becomes more important than peripheral acuity in the search task. Search time is proportional to the number of objects in the display, and introduction of a linear cue into the display greatly decreases search time. Author

**N65-12641#** Flying Personnel Research Committee (Gt. Brit.)
**OXYGEN FOR CIVIL AIRCREW FOLLOWING LOSS OF CABIN PRESSURISATION**
H. L. Roxburgh Jul. 1963 8 p refs
(FPRC/Memo.205)

An evaluation is presented of the risks associated with the compromises that have arisen or been suggested for aircrew oxygen systems in civil aircraft. Unlike military aviation, complete loss of cabin pressure is not always considered as a foreseeable risk, and aircrew training in decompression techniques and the use of oxygen masks is often lacking. The obvious impossibility of designing a standard oxygen mask to fit all faces leads to a discussion of methods of countering the effects of mask leakage: (1) delivery of a rich oxygen mixture; (2) use of a small positive pressure in the mask; and (3) constant flow of oxygen. It is recommended that a constant flow system be considered for all aircraft where mask fit is not ensured by fitting and training. However, such systems are unsuitable for altitudes above 40 000 ft where a fitted mask is essential, and involve some risk above 30 000 ft because the mask is not on the face before decompression. M.P.G.

**N65-12653#** Michigan U., Ann Arbor. Coll. of Literature, Science, and the Arts
**RETENTION OF TRACKING SKILLS Final Report**
Arthur W. Melton Sep. 1964 40 p refs
(Contract DA-49-007-MD-1020)
(Rept.-02855-1-F; AD-606236)

The concept of the compatibility of display-control coding with "population stereotypes" for such coding is discussed with respect to the concepts of the interference theory of forgetting, as developed in the context of verbal learning and retention. Using an eye–hand pursuit-tracking task, a preliminary experiment was accomplished in which a few human subjects were given large amounts of practice with compatible and incompatible display-control relationships and with short (2- to 3-day) or long (10- to 40-day) intervals between practice days. The results of the study favored a hypothesis of differential forgetting of tasks involving compatible and incompatible display-control relationships, but only when a coherent target motion (repetitive, nonrandom) was involved. P.V.E.

**N65-12662#** Joint Publications Research Service, Washington, D.C.
**THE DYNAMICS OF EMOTIONAL-VOLITIONAL PROCESSES IN ASTRONAUTS DURING PARACHUTE JUMPS**
G. F. Khlebnikov and V. I. Lebedev 14 Dec. 1964 18 p refs
Transl. into ENGLISH from Vopr. Psikhologii (Moscow), no. 5, 1964 p 3–10
(JPRS-27819; TT-64-51930) OTS: $1.00

Before emplaning and after landing, the heart rate was measured, and the dynamometry of the hands was carried out. The registered changes in hand strength and in heart rate indicated the emotional "tuning" of cosmonauts to the coming parachute jumps. On the first day of parachute jumping the emotional reactions were markedly different from those of well-trained parachutists. But with training of the volitive processes the emotional manifestation at the repeated parachute jumpings became weaker. Author

**N65-12802*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**MANUAL-CONTROL SIMULATION STUDY OF A NON-LIFTING VEHICLE DURING ORBIT, RETRO-ROCKET FIRING, AND REENTRY INTO THE EARTH'S ATMOSPHERE**
Roger M. Davidson, Donald C. Cheatham, and Jack T. Kaylor Washington, NASA, Sep. 1960 62 p refs
(NASA-TM-X-359) OTS Prices: HC $3.00/MF $0.75
(Declassified)

The six-degree-of-freedom equations of motion for a nonlifting reentry vehicle, such as the Mercury capsule, were solved by an analog computer. The pilot was used to close the control loop. A number of variations in instrument display, side-arm controller, and control-torque output variation with controller displacement were made. The conclusions reached as a result of both pilot opinion and data obtained were that a human pilot is capable of controlling the vehicle dynamics during orbital flight, retrorocket firing (including large misalinement torques), and reentry. In general, orbital control was found easy, and reentry control was a little more difficult. Control of the vehicle while firing the retrorockets, with the associated large misalinement torques, was very difficult but possible. Author

**N65-12974#** Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
**RESPIRATORY GAS ANALYSIS WITH A TIME-OF-FLIGHT MASS SPECTROMETER Final Report, Jun. 1961–Jun. 1964**
J. B. Graves and P. R. B. Caldwell Sep. 1964 14 p ref
(AMRL-TR-64-84; AD-608339)

A modified remote-sampling system was devised for the Bendix Model 17-210 time-of-flight mass spectrometer. This was adapted for use in measuring respiratory gases breath by breath. The stability of the mass-spectrometer output shows a variation of ±5%. The sensitivity of the system for oxygen is in the range of 0.2% absolute concentration. The accuracy for oxygen is within ±5%. Author

**N65-12995#** General Electric Co., Philadelphia, Pa. Missile and Space Div.
**EMERGENCY BREATHING AND SUIT PRESSURIZATION SYSTEM**
R. A. Miller and D. J. Withey Wright-Patterson AFB, Ohio, Aerospace Med. Res. Labs., Sep. 1964 45 p
(Contract AF 33(657)-11345)
(AMRL-TR-64-60; AD-608088)

The design and fabrication of an emergency breathing and suit pressurization system (EBSPS), capable of sustaining three full-pressure suited crewmen within the Aerospace Medical Research Laboratories life-support-system evaluator, were investigated. Two operating modes are provided: (1) When the evaluator is pressurized, the emergency breathing and suit pressurization system operates as an open-loop system and ventilated the pressure suit and the ambient air. (2) When the evaluator is depressurized, the emergency breathing and suit pressurization system operates as a closed environmental control system, and provides the crewmen with a habitable atmosphere. In this latter mode, the system regulates the suit pressure, the $CO_2$ partial pressure, relative humidity, composition (100% $O_2$), and temperature of the ventilating air, and supplies oxygen for breathing and leakage makeup as required. In all modes, the emergency breathing and suit pressurization system regulates the flow of ventilating atmosphere through the pressure suits. Author

**N65-12996#** Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio. Behavioral Sciences Lab.
**THE EMERGING ROLE OF ENGINEERING PSYCHOLOGY Final Report**
Julien M. Christensen Sep. 1964 20 p refs
(AMRL-TR-64-88; AD-608215)

The history of engineering psychology and its relationship to engineering are briefly traced. The emergence of engineering psychology from the "knobs and dials" stage to a full-fledged participating profession in systems planning and development is described. Some of the problems confronting engineering psychology are described, the chief of which is the development of suitable educational programs in a sufficient number of universities to supply the current and anticipated demand for workers in this area. Author

# 06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

**N65-12345#** Naval Research Lab., Washington, D.C. Chemistry Div.
**SOME PHYSICAL PROPERTIES OF SOAP/SOLVENT SYSTEMS AND THEIR RELATION TO THE SOLUBILITY PARAMETER OF THE SOLVENT Interim Report**
R. C. Little 21 Aug. 1964 7 p refs
(NRL-6135; AD-606293) OTS: $0.50

Certain solubility-linked physical properties of soap solvent systems were shown to be functions of the solubility parameter of the solvent. The lowest critical solution temperatures for zinc and lead stearates occur in solvents with a solubility parameter of 8.9. Maximum swelling of lithium and sodium stearate–solvent systems occurs at a solvent solubility parameter of 9.3. In addition, the gel–jelly-or-sol transition temperatures for aluminum dilaurate–solvent systems were shown to be an approximately linear function of the solvent-solubility parameter. A qualitative explanation for the observed results is based upon an analogy to high-polymer–solvent systems. Author

**N65-12409*#** Aerojet-General Corp., Azusa, Calif. Chemical Products Div.
**RESEARCH ON PROCESSES FOR UTILIZATION OF LUNAR RESOURCES Quarterly Report, 16 Jul.–15 Oct. 1964**

S. O. Rosenberg, G. A. Guter, and F. E. Miller Oct. 1964 25 p /ts Rept.-0765-03-1
(Contract NAS7-225)
(NASA-CR-59633) OTS Prices: HC $1.00/MF $0.50

Laboratory apparatus has been placed in operation for studying two of the important steps in the Carbothermal process. A silicate reduction unit was designed, fabricated, and tested. The unit will handle a charge of 1 lb of silicate material, and utilizes a resistance-heated furnace. An automatically controlled carbon monoxide reduction reactor was put into operation for long-term catalyst life studies. This unit gives quantitative conversion of carbon monoxide with excellent water and methane yields. To date, it has operated for more than 600 hours without any apparent change in catalyst activity. Author

**N65-12431#** Naval Research Lab., Washington, D.C.
**PHOTODEGRADATION OF HIGH POLYMERS IN SOLUTION. PART I: SOLVENT EFFECTS IN THE PHOTOLYSIS OF POLY($\alpha$-METHYLSTYRENE) Interim Report**
R. B. Fox and T. R. Price 25 Aug. 1964 25 p refs
(NRL-6120; AD-606392) OTS: $0.75

The photodegradation of poly($\alpha$-methylstyrene) has been investigated in the presence and absence of air in a series of solvents under irradiation by a low-pressure mercury lamp at about 25° C. Changes in the intrinsic viscosities of the solutions, as well as spectral changes, are used to follow the course of the degradation. Under most conditions, random scission is the major degradation reaction; no cross linking is observed. Typical quantum yields for random scission in solution (1 gram/deciliter) are: benzene, 0.00005; dioxane, 0.0005; cyclohexane, 0.0006; methylene chloride, 0.005; chloroform, 0.16; and carbon tetrachloride, 0.17 scission per quantum absorbed by the solution. Values in the presence or absence of air are similar although the mechanisms may be different. As polymer concentration increases, the quantum yield decreases. Author

**N65-12432#** California U., Berkeley.
**THE SOLUBILITY OF QUARTZ IN $H_2O$ IN THE RANGE 1000-4000 BARS AND 400-550°C**
7 Jul. 1964 27 p refs
(Contract Nonr-365601)
(AD-606185)

The solubility of quartz in $H_2O$ has been measured between 1 to 4 kilobars at 400°, 450°, 500°, and 550° C. Two rate studies at 400° and 625° C are consistent with an equation of the form $dx/dt = a - bx$ for the rate of solution of quartz in $H_2O$, where x is the concentration of $SiO_2$ in solution at time t. The temperature dependence of the two specific rate constants, a and b, give values of approximately 16.5 and 14.5 kcal/mole for the activation energies of the dissolution and crystallization processes, respectively. Author

**N65-12433#** Oak Ridge National Lab., Tenn. Isotopes Information Center
**PUBLICATIONS ON ISOTOPES AT OAK RIDGE NATIONAL LABORATORY, 1946–1963**
Robert H. Lafferty, Jr., P. S. Baker, and Martha Gerrard Jul. 1964 315 p refs
(ORNL-11C-1) OTS: $4.00

This bibliography refers to the work on the preparation of radioactive isotopes, the separation of stable isotopes by the electromagnetic and other methods, the preparation of sources and targets, the radioactive properties and other physical properties of isotopes, the isotopes in inorganic and organic chemistry, the activation analysis, the isotopes in analytical methods, and the isotopes in biology. G.G.

**N65-12470*#** George Washington U., Washington, D.C.
**SOLVENT AND TEMPERATURE EFFECTS ON FLUORESCENCE EMISSION OF EUROPIUM $\beta$–DIKETONATES**
N. Filipescu and N. Mc Avoy (NASA. Goddard Space Flight Center) [1964] 15 p refs Submitted for Publication
(Grant NsG-603)
(NASA-CR-59724) OTS Prices: HC $1.00/MF $0.50

The fluorescence intensity of the $^5D_0 \rightarrow {}^7F_2$ transition of trivalent europium ion in differently substituted $\beta$-diketone chelates was determined in solvents of different polarity, over a wide range of temperatures. Author

**N65-12471*#** Clemson Coll., S.C.
**SOME TRANSITION METAL COMPLEXES OF 8-AMINOQUINOLINE**
James C. Fanning and Larry T. Taylor [1964] 27 p refs Presented at the 148th Natl. Meeting of the Am. Chem. Soc., Chicago, Sep. 1964 Submitted for Publication
(Grant NsG-(T)-44)
(NASA-CR-59725) OTS Prices: HC $2.00/MF $0.50

The reaction of 8-aminoquinoline with chromium(III), manganese(II), iron(II) and (III), cobalt(II), nickel(II), copper(II), zinc(II), cadmium(II), and platinum(II) salts was studied. In many instances definite compounds were prepared. Magnetic moments, molar conductances, and infrared, visible, and ultraviolet spectra were measured for some of these compounds. Stability constants were obtained for the copper(II) complex by using Leden's method. The 8-Aminoquinoline was found to be very susceptible to oxidation in the presence of certain metal ions. Author

**N65-12484#** Allied Chemical Corp., Morristown, N.J. General Chemical Div.
**HIGH PRESSURE-BASIC RESEARCH PROGRAM Interim Technical Report, May 1, 1962–Mar. 31, 1964**
W. H. Mears, E. S. Jones, R. J. Chandross, P. N. Lamori, K. P. Murphy et al [1964] 48 p refs
(Contract DA-30-069-ORD-33551)
(AD-447217)

This study pertains to organic fluorocarbon reactions at ultrahigh pressures, and also to the inorganic synthesis in the system boron–phosphorus–nitrogen–carbon. A new encapsulation technique was developed, which permits the reaction of gases boiling as low as −100° C at pressures up to 45 k. G.G.

**N65-12487#** Midwest Research Inst., Kansas City, Mo.
**STRUCTURAL STUDIES OF INORGANIC OXIDIZERS Quarterly Report, 1 Jul.–30 Sep. 1964**
F. V. Morriss 4 Nov. 1964 14 p refs
(Contracts AF 04(611)-10215; ARPA Order-24)
(QR-1; AD-450929)

The purification of $OF_2$ and $NF_3$ was accomplished by bleeding the gases from tanks through an HF trap and subsequently condensing them on a cold, vertical column jacketed with a Dewar. The gases were chromatographed for $N_2F_4$ and the relative elution times of the impurities found were listed. The eluted gases were finally condensed either in an EPR tube, in a flash-photolysis Dewar, or in an infrared cell. It was found that $OF_2$ (liquid) is not paramagnetic; however, a paramagnetic species is produced in the pure material by the absorption of ultraviolet radiation. The flash photolysis and ultraviolet–visible spectroscopy data on $OF_2$, $NF_2$, and $OF_2$-$NF_3$ mixtures were parallel to the EPR observations. G.G.

N65-12488# Texaco Experiment Inc., Richmond, Va.
**PARA-ORTHO HYDROGEN CONVERSION Third Quarterly Progress Report, Dec. 1963–Feb. 1964**
Gordon H. Miller and Lloyd J. Parcell 12 Mar. 1964 14 p refs
(Contract AF 33(657)-11123)
(EXP-430; TM-1513; AD-439663)

The principle of para–ortho conversion of hydrogen upon its diffusion through a palladium–silver alloy membrane has been demonstrated. Also, the dissociative mechanism leading to this conversion was demonstrated by deuterium exchange upon diffusion through the palladium–silver alloy and through palladium-coated iron. Gaseous hydrogen diffusion through untreated iron was too slow to measure; however, the palladium-coated iron showed prompt diffusion. The diffusion rate through palladium–silever alloy is relatively large at room temperature, but it decreases rapidly with temperature decrease. Proper surface preparation may increase the diffusion to a favorable rate, even at low temperatures. Author

N65-12504*# Florida U., Gainesville.
**MASS SPECTRA OF POSITIVE AND NEGATIVE IONS IN NITROUS AND NITRIC OXIDES**
C. S. Harden and E. E. Muschlitz, Jr. Washington, NASA, Dec. 1964 23 p refs
(Grant NsG-67-60)
(NASA-TN-D-2555) OTS Prices: HC $1.00/MF $0.50

Using a high-resolution mass spectrometer containing an electron-impact ion source, the mass spectra of positive and negative ions in $N_2O$ and NO have been studied for possible gas phase ion–molecule reactions. Over a pressure range of 0.05 to 0.5 microns Hg, as measured by a Pirani gauge in the ion source, no such reactions were observed. The formation of $NO^-$ by electron impact in NO was found to be second-order pressure dependent at low pressures and first order at higher pressures. Initial electron attachment followed by collision stabilization is proposed as the mechanism for the process. The formation of $NO^-$ ions from $N_2O$ molecules was found to deviate slightly from a first-order pressure dependence toward second order. An intense peak at mass 26 was observed in the negative ion spectra of both $N_2O$ and NO. Author

N65-12510# Brookhaven National Lab., Upton N.Y.
**PROCESS RADIATION DEVELOPMENT PROGRAM SUMMARIES**
Otto A. Kuhl et al [1964] 52 p refs Presented at the 4th Ann. Contractors Meeting, Upton, N.Y. 18–19 Jun. 1964
(BNL-874(C-41)) OTS: $1.25

Summaries of programs involving the use of radiation in physiochemical technology, particularly the synthesis and polymerization of chemical compounds, are presented. Among the process radiation products discussed are organotin compounds, fluorine and fluorocarbon compounds, ethylene, organic polymers and monomers, polypropylene upgrading, colloids, membranes, and wood–plastic combinations. Other radiation uses being investigated include inhibition of bacteria growth in JP-4 fuel, neutron-transmutation doping of semiconductors, radiation dosimetry and calorimetry, and radiolysis uses. M.P.G.

N65-12516# American Meteorological Society, Boston, Mass.
**POLYMERS WITH A CONJUGATED BOND SYSTEM AND HETEROATOMS IN THE CONJUGATION CHAIN. XX: SYNTHESIS OF POLYMERIC PHTHALOCYANINES AND INVESTIGATION OF THEIR BASIC PHYSICOCHEMICAL PROPERTIES [POLIMERY S SISTEMOI SOPRIAZHENIIA. XX: SINTEZ I ISSLEDOVANIE OSNOVNYKH FIZIKO-KHIMICHESKIKH SVOISTV POLIMERNYK FTALOTSIANINOV]**
A. A. Berlin, L. G. Cherkashina, and E. I. Balabanov Bedford, Mass. AFCRL, Mar. 1964 15 p refs Transl. into ENGLISH from Vysokomol. SOEDINENIYA (USSR), v. 4, no. 3, 1962 p 376–382
(Contract AF 19(628)-3880)
(T-R-431+; AD-602182)

Substances containing phthalocyanine cycles with chelate-bound atoms of metals in their conjugation chain were studied for their electric, magnetic, and thermal properties. The polymeric phthalocyanines were synthesized from pyromellitic acid and phthalic anhydride, and from 3,3',4,4'-tetracarboxydiphenyl ether and phthalic anhydride. It was established that, as a rule, samples of polymers with a high electric conductivity also have EPR signals of higher intensity. G.G.

N65-12534# Iowa State U. of Science and Tech., Ames. Ames Lab.
**PROPAGATION CHARACTERISTICS OF CAPILLARY RIPPLES ON SOLUTIONS OF LOW MOLECULAR-WEIGHT ORGANIC ACIDS**
Stuart C. Grossman and R. S. Hansen Jul. 1964 82 p refs
(Contract W-7405-ENG-82)
(IS-855) OTS: $2.00

The viscoelastic theory for ripples at a liquid–air interface has been sketched. It includes corrections for any gravity effects. The electronic instrumentation has been modified to include frequencies below 200 cps. The weight of the ripple generator is an important factor to consider as it should be heavier for the lower frequencies and lighter for the higher ones. Water and solutions of low-molecular-weight organic acids were studied. These acids were propionic, n-butyric, isobutyric, n-valeric, isovaleric, n-caproic, and n-heptanoic. Water follows a nonviscoelastic theory at the three temperatures studied. The acids required only one adjustable parameter in the theory presented by Hansen and Mann. The acids up to four carbon atoms form slightly viscoelastic solutions. N-valeric, isovaleric, n-caproic acid, and n-heptanoic acid solutions are described by the theory for intermediate viscoelastic films. Author

N65-12539# California U., Berkeley.
**PHENOMENA AT A GAS-ELECTRODE-ELECTROLYTE INTERFACE**
Douglas Noel Bennion 1 Jun. 1964 150 p refs
(Contract DA-36-039-SC-89153)
(TR-3; AD-602701) OTS: $5.00

The purpose of this investigation is to determine where the reaction takes place spatially and what factors control the distribution and rate of the reaction. The variation of current density distribution along a plane, partially immersed electrode relative to the apparent meniscus has been measured as a function of total applied current. Measurements are reported for the cathodic current density distribution of $O_2$ gas and aqueous KOH electrolyte on sectioned Ni and Ag electrodes. These measurements show that the current extends well above the apparent meniscus into a thin electrolyte film on the surface of the electrode. The behavior of this system can be predicted by a mathematical model. A comparison of the theoretical and experimental approaches indicates that the current density distribution is controlled by a balance between charge transfer overpotential and ohmic resistance drop in the electrolyte film. Author

N65-12562# Aerospace Corp., El Segundo, Calif. Lab. Operations
**ABSORPTION COEFFICIENTS OF $Cl_2$ AT HIGH TEMPERATURES**

T. A. Jacobs and R. R. Giedt 15 Nov. 1964 25 p refs
(Contract AF 04(695)-469)
(SSD-TDR-64-245; TDR-469(5240-20)-1; AD-452235)

The shock tube has been used to measure continuum absorption coefficients of $Cl_2$ at several frequencies, over the temperature range 1000° to 2000° K. Experimental results are compared with the theoretical expressions of Sulzer and Wieland, and of Wilkins. Author

**N65-12565** Army Missile Command, Huntsville, Ala. Redstone Scientific Information Center
**SYNTHESIS, POLYMERIZATION, AND COPOLYMERIZATION OF POLYORGANOSILOXANES CONTAINING METHACRYLATE GROUPS. II: INVESTIGATION OF POLYMERIZATION AND COPOLYMERIZATION BY MEANS OF IR SPECTRA**
I. A. Alekseyeva, G. A. Semerneva, L. A. Samarina, M. A. Bulatov, and S. S. Spasskiy 3 Nov. 1964 9 p refs Transl. into ENGLISH from Vysokomol. Soedineniya (USSR), v. 6, No. 2, 1964 p 265–268
(RSIC-160; AD-418055)

The role of space factors in the polymerization of polyfunctional polymers containing double bonds in the side chains was investigated using a block polymerization of methacrylate polysiloxanes and a copolymerization of methacrylate polysiloxanes with styrene. The unreacted double-bond content was investigated by infrared absorption spectroscopy to determine the optical density of the absorption bond of groups that change in content in the course of the reaction to that of the unchanged groups. With increase in dimethyl silicate content in the block-polymerized methacrylate polysiloxanes, the ratio of the optical densities before and after polymerization decreases monotonically, due to decrease in double-bond content. With increase of the distances between linkages containing methacrylate groups, the number of reacted double bonds increases; at short distances more than 40% of the double bonds fail to react, probably due to stearic hindrance. The double bond is practically unobserved in the copolymers with styrene. M.P.G.

**N65-12595#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**RELATIONSHIPS AFFECTING CHEMICAL BONDING IN ELECTRON PARAMAGNETIC RESONANCE SPECTRA**
Olimpiu Constantinescu 30 Oct. 1964 20 p refs Transl. into ENGLISH from Acad. Rep. Populare Romine, Studii Cercetari Fiz. (Bucharest), v. 13, no. 5, 1962 p 795–806
(FTD-TT-64-460/1+2+3+4; AD-451122)

Electronic and quantum theories of chemical bonding are discussed, and several independently measurable parameters of compounds such as $BeCl_2$ and $K_4Fe(CN)_6$ are derived. The method of orbitals and the method of valence bonds are applied in different cases, and the magnetic properties of the transition-element complexes of the $MX_6$ type are discussed. D.E.W.

**N65-12670#** Iowa State U. of Science and Tech., Ames. Ames Lab.
**SOME BIS(DIALKYLPHOSPHINYL) METHANES AS SOLVENT EXTRACTANTS**
James Roger Parker and C. V. Banks Jun. 1964 191 p refs
(Contract W-7405-ENG-82)
(IS-942) OTS: $3.00

An extensive review of some of the more important neutral organophosphorus compounds as solvent extractants was given. The compounds included were tri-*n*-butyl phosphate, TBP, tri-*n*-octylphosphine oxide, TOPO, tris(2-ethylhexyl)phosphine oxide, TEHPO, and bis(di-*n*-hexylphosphinyl)methane, HDPM. A review was also given on the effects of structure on the extracting power of neutral organophosphorus compounds. It was found that many phosphoryl-containing compounds could be titrated as bases. By studying the extraction of nitric acid, a relative order of basicity was established for certain of the phosphine oxides. The TOPO was found to be more basic than TEHPO, and HDPM was found to be more basic than bis(di-2-ethylbutylphosphinyl)methane, EBDPM, which in turn was more basic than bis(di-2-ethylhexylphosphinyl) methane, EHDPM. Author

**N65-12771#** Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.
**AN ELECTRON MICROSCOPE STUDY OF THE OXIDATION OF SOME ZIRCONIUM ALLOYS IN STEAM**
J. H. Chute Aug. 1964 25 p refs
(AECL-1999) Available from Atomic Energy of Canada, Chalk River: $1.00

An electron microscope study has been made of the oxide films formed on zirconium, Zircaloy-2, and Zr-0.5 wt% Cu-0.5 wt% Mo. A thin layer of cubic $ZrO_2$ was observed on the surface of the oxide under all conditions, and was apparently formed (to a thickness of ~ 150 Å) during the initial stages of oxidation. The crystallite size of thin oxide films ranged from < 100 Å on the Zr-0.5 wt% Cu-0.5 wt% Mo alloy oxidized at 400° C to 100 to 200 Å for films formed at 650° C. Examination of specimen surfaces by a replica technique showed the development of cracks in the oxide. Author

**N65-12789#** American Cyanamid Co., Stamford, Conn. Central Research Div.
**CHEMILUMINESCENT MATERIALS Technical Report, 1 Jun.–31 Aug. 1964**
M. M. Rauhut et al [1964] 56 p refs
(Contract Nonr-4200(00); ARPA Order 299)
(TR-5; AD-606989)

Two approaches are being taken to achieve an understanding of the chemiluminescence mechanism. The first approach involves direct studies of several known chemiluminescent reactions, including the following: (1) the chemiluminescent reaction of oxalyl chloride with hydrogen peroxide in the presence of 9,10-diphenylanthracene; (2) thermal decomposition of anthracene photoperoxides; and (3) ion radical electron transfer chemiluminescence. The second approach involves exploratory studies of new, potentially chemiluminescent reactions designed to test working hypotheses and to provide structural criteria for chemiluminescent compounds. Synthesis efforts to prepare acridine and anthracene derivatives are described. D.S.G.

**N65-12831#** Battelle Memorial Inst., Columbus, Ohio.
**PREPARATION AND PROPERTIES OF CAST UN**
Roy W. Endebrock, Ellis L. Foster, Jr., and Donald L. Keller 28 Aug. 1964 26 p refs Joint US-EURATOM Res. and Develop. Program
(Contract W-7405-ENG-92)
(BMI-1690; EURAEC-1206) OTS: $0.50

Methods were developed to prepare uranium mononitride, both as polycrystalline material and as large single crystals, by consumable-electrode arcmelting procedures. The UN single crystals exhibited an average Knoop hardness of 555 and a Vickers hardness of 515. Densities obtained by the displacement technique varied from 99% to 100% of theoretical.

Congruent melting occurred at 2850° ± 50° C at and above a nitrogen pressure of 2.5 atm. An initial film of oxide that formed on crystal surfaces offered protection from further oxidation. Some information regarding UN structure as determined from single crystals of UN was also obtained. Hot-hardness values for single crystals at 1000° C and above were about 30% lower than those of hot isostatically pressed UN power. Author

**N65-12838*#** Lockheed Missiles and Space Co., Sunnyvale, Calif. Material Sciences Lab.

**ELECTROLYTIC PREPARATION OF HIGH DIELECTRIC FILMS Quarterly Report, 3 Aug.–3 Nov. 1964**

A. E. Hultquist and M. E. Sibert [1964] 22 p refs

(Contract NASw-969)

(NASA-CR-59811) OTS Prices: HC $1.00/MF $0.50

This report on the preparation of high dielectric films is concerned with procedures for producing films containing $BaTiO_3$. The most promising methods are the direct occlusion of $BaTiO_3$ particles from an aqueous basic bath, and the deposition of a material from a hydrolyzed, isopropyl titanate bath containing $Ba(OH)_2$. Both of these methods can place the material at the anode surface. Further work is necessary to develop a procedure for making a coherent and adherent film. Attempts to reproduce earlier work with the barium acetate-EDTA bath have not produced equivalent films. The need for additional film evaluation techniques including capacity as a function of temperature and frequency is discussed. Author

**N65-12846#** Applied Physics Lab., Johns Hopkins U., Silver Spring, Md.

**THERMAL DEGRADATION OF AN AROMATIC POLYPYROMELLITIMIDE IN AIR AND VACUUM. II: THE EFFECT OF IMPURITIES AND THE NATURE OF DEGRADATION PRODUCTS**

S. D. Bruck May 1964 28 p refs

(Contract NOw-62-0604-c)

(TG-573; AD-608766)

The effect of impurities on the thermal degradation of poly[N,N'-(p,p'-oxydiphenylene) pyromellitimide] (du Pont's H-film) is discussed. Purification of the polymer in dimethylformamide decreases the rates of degradation both in air and in vacuum, but only slightly reduces the activation energies. Infrared and mass spectrometric data suggest the participation of polypyromellitamic acid (polyamide acid) impurity in the degradation process by thermal cleavage of its carboxyl and hydrolytic scission of its amide groups. As far as the vacuum pyrolysis of the main polyimide chains is concerned, the activation energy of 74 kcal/mole, bond dissociation energies, and elemental analysis of the residue remaining after pyrolysis suggest that the primary scission occurs at the imide bonds, most likely followed by a secondary cleavage resulting in the elimination of CO groups. Author

**N65-12866#** Little (Arthur D.) Inc., Cambridge, Mass.

**STRUCTURE MAKERS AND BREAKERS IN WATER: PRESSURE-INDUCED CHANGES IN THE HYDRATION ATMOSPHERES OF IONS IN SOLUTION**

R. A. Horne 30 Sep. 1964 28 p refs Submitted for Publication

(Contract Nonr-4424(00))

(TR-3; AD-449831)

The alkali metal cations may be divided into two classes. Class I consists of $Li^+$ and $Na^+$, which have four waters symmetrically arranged in their innermost solvation sheath. The application of hydrostatic pressure reduces this number to 1. Members of this class are structure makers and have positive viscosity B-coefficients. Class II consists of $K^+$ $Rb^+$, and $Cs^+$, which have one water in their innermost solvation sheath, which are completely dehydrated by the application of pressure, and which, due to their asymmetry, are structure breakers with negative B-coefficients. The $Br^-$ and $Cl^-$ tend to resemble Class II, but $F^-$ and $I^-$ are exceptional in certain respects. The $I^-$ appears to be unhydrated even at one atmosphere. Author

**N65-12941#** Iowa State U. of Science and Tech., Ames. Ames Lab.

**THE EFFECT OF OXYGEN ON THE RECOIL REACTIONS OF CARBON-11 IN HYDROCARBONS**

Dale Byron De Vries and A. F. Voigt Jun. 1964 81 p refs

(Contract W-7405-ENG-82)

(IS-866) OTS: $2.00

The recoil reactions of carbon-11 produced by the $C^{12}(\gamma,n)C^{11}$ reaction in benzene, cyclohexane, and n-hexane have been studied. Using gas chromatography for the analysis, the yields of carbon-11 labeled methane, ethane, ethylene, and acetylene were determined. The effect of radiation dose and oxygen scavenger on these yields was investigated. With the exception of acetylene, all the yields observed were found to be sensitive to radiation dose. It was also observed that the extrapolation of product yield versus dose curves to zero dose gave the same value for the product yield that was found with oxygen scavenger present. Using these values of product yield, it was found that the acetylene yield increased from benzene to cyclohexane to n-hexane. Very small amounts of methane and no two-carbon products other than acetylene were observed for benzene. The methane yield was larger in cyclohexane than in n-hexane, but the yields of ethane and ethylene were smaller in cyclohexane. These results are discussed in terms of the nature of the recoil carbon-11 atom as it dissipates its kinetic energy in the system. Author

**N65-12944#** Air Force Systems Command, Wright-Patterson AFB, Ohio. AF Materials Lab.

**EXPERIMENTAL TECHNIQUES FOR SOFT X-RAY SPECTROSCOPY Technical Documentary Report, Sep. 1962–Oct. 1963**

David W. Fischer and William L. Baun Feb. 1964 51 p refs

(RTD-TDR-63-4232; AD-431734)

Instrumentation for soft X-ray research is briefly described. Preliminary results are shown for several dispersing systems that have been found useful in the 10 to 100 Å region. Results from single crystals of group 1A salts of phthalic acid are discussed, and intensity measurements are reported. Other organic single crystals such as long-chain derivatives of adipic acid are evaluated, along with films of organic compounds prepared by the Blodgett–Langmuir technique. The efficiencies of the dispersing elements mentioned above are compared with commercial crystals such as mica, ADP, and EDDT. Performance of detectors for soft X-rays is shown for flow proportional and Geiger counters, solid-state silicon barrier detector, and a windowless-resistance-strip magnetic electron multiplier. The relative efficiencies of several photocathode materials for the latter detector are discussed. A design is discussed for a scintillation counter sensitive over a wide energy range, and preliminary results are shown using the counter in the region 1 to 15 Å. Author

**N65-12983#** Iowa State U. of Science and Tech., Ames. Ames Lab.
**VOLUME-TEMPERATURE RELATIONSHIPS OF SOME RARE EARTH CHLORIDE SOLUTIONS**
Wayne Merlyn Gildseth and F. H. Spedding Aug. 1964 186 p refs
(Contract W-7405-ENG-82)
(IS-992) OTS: $5.00

A dilatometric apparatus was constructed which was capable of measuring the change in density of a liquid or solution with an accuracy of about 2 ppm over the temperature range of 20° to 80° C. The variations of the volumes of the dilatometers with temperature were determined using mercury as a standard. Densities of water and aqueous lanthanum chloride and neodymium chloride solutions were determined at five-degree temperature intervals from 20° to 80° C. Twelve lanthanum chloride solutions ranging in concentration from 0.06362 to 3.3907 molal and eleven neodymium chloride solutions ranging in concentration from 0.1050 to 3.4160 molal were investigated. These data were used to calculate coefficients of thermal expansion of water and the rare-earth chloride solutions. Apparent and partial molal volumes of the salt, apparent and partial molal expansibilities of the salt, and partial molal volumes and expansibilities of water in these rare-earth chloride solutions were also calculated. Empirical least square equations were computed with the use of an IBM 7074 computer to represent the above properties versus temperature and versus concentration. Author

**N65-12990#** Air Force Systems Command, Wright-Patterson AFB, Ohio. AF Flight Dynamics Lab.
**INVESTIGATION OF CATALYTIC REACTIONS FOR $CO_2$ REDUCTION. PART I: EVALUATION OF A NICKEL-KIESELGUHR CATALYST Technical Documentary Report, Jun.–Oct. 1963**
Edward B. Thompson, Jr. Oct. 1964 46 p refs
(FDL-TDR-64-22, Pt. I; AD-608411)

A nickel–kieselghur methanation catalyst was selected as the initial catalyst for promoting the reduction of carbon dioxide by hydrogen to methane and water. A catalytic reactor was designed, fabricated, and evaluated utilizing the nickel–kieselguhr methanation catalyst. The reactor processed 2.2 pounds of $CO_2$ per day. The minimum temperature to achieve the maximum $CO_2$ conversion rate of 98% for this catalyst was 575° F at a pressure of 1 atm. The total weight of hydrogen to reduce the 2.20 pounds of $CO_2$ under these conditions is 0.397 pounds. The same batch of catalyst, weighing 300 grams, was used during this phase. The catalyst was periodically examined for possible carbon deposition and physical deterioration. While neither of these effects was perceptible, it became necessary to purge the catalyst with hydrogen before each experiment to offset the increasing effect of sulfur poisoning. The report includes a discussion of the theory of catalysis. Author

**N65-13010#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CONCERNING THE PROBLEM OF THE DECOMPOSITION MECHANISM OF AMMONIUM PERCHLORATE**
A. V. Rayevskiy and G. B. Manelis 6 Oct. 1964 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 151, no. 4, 1963 p 886–889
(FTD-TT-64-768/1+2; AD-608052)

Microcinematography of the thermal decomposition process was conducted on single crystals of ammonium perchlorate. Experimental conditions and techniques for growth of single crystals and for controlled decomposition of the crystals are described. Microscopic analysis of the decomposition process of ammonium perchlorate at temperatures of 210° to 236° C showed that the decomposition reaction begins at discrete points of the crystal and develops by means of a growth of the evolving nuclei. The nuclei appear close to the surface of a single crystal, at a depth of 20 to 30 microns, and actually consist of clumps of large numbers of spherical seeds. The seeds oscillate slowly within the clump until they fuse with the growing central nuclei of decomposition. Further steps of the decomposition process are detailed, and the activation energies of nucleus growth in directions parallel and perpendicular to the crystal grain are given. D.E.W.

**N65-13032#** Colorado U., Boulder.
**KINETICS AND DIFFUSION STUDY OF THE PARA-ORTHO-SHIFT OF HYDROGEN**
P. L. Barrick, L. F. Brown, and H. L. Hutchinson Wright-Patterson AFB, Ohio, AF Aero Propulsion Lab., Sep. 1964 233 p refs
(Contract AF 33(616)-7654)
(APL-TDR-64-77; AD-606495)

A broad investigation into factors affecting the rate of the para-ortho hydrogen shift reaction, when promoted by the ferric oxide gel catalyst, is reported. The investigation included studies of the kinetics of the reaction, the effects of diffusion within the catalyst particle, the relation between catalyst surface area and activity, the effects of diffusion external to the catalyst particles, and the technique of preparation and activation of the catalyst. It was concluded that when diffusion effects are absent, the rate of the reaction may be expressed by $r = k(c_p - c_{pe})/1 + k'c_p$, where r is the rate of conversion, $c_p$ is the concentration of parahydrogen, $c_{pe}$ is the equilibrium concentration, and k and k' are constants. Also, improved activation procedures were shown to produce a catalyst with more than double the highest activity previously reported for ferric oxide gel catalysts. D.E.W.

**N65-13049#** AVCO-Everett Research Lab., Everett, Mass.
**EXTENSIONS OF THE VARIATIONAL THEORY OF CHEMICAL REACTIONS**
Benjamin J. Woznick Nov. 1964 23 p refs
(Contracts AF 04(694)-414; DA-19-020-AMC-0210; Proj. Defender)
(AVCO-Everett Res. Rept.-199; BSD-TDR-64-149; AD-450966)

The variational theory of chemical reactions has been extended to provide estimates for reaction rates across surfaces parallel to the tangent of the rotational barrier, and for the case of three-body recombination in the presence of a catalyst whose dominant interaction with the recombining atoms is attractive. Author

**N65-13073#** Harshaw Chemical Co., Cleveland, Ohio. Central Research Lab.
**INVESTIGATION OF THE EXISTENCE OF OXYANIONS OF FLUORINE AND NITROGEN AND THE NITROGEN-FLUORINE CATIONS Quarterly Technical Summary Report, 28 Jul.–28 Oct. 1964**
Gerald L. Hurst and S. I. Khayat 28 Nov. 1964 22 p refs
(Contract DA-31-124-ARO(D)-76; ARPA Order 402)
(HQ-76-7; AD-405529)

The preparation of trans-$N_2F_2$ from $N_2F_4$ and $AlCl_3$ in a flow system is described. The thermal isomerization of trans-$N_2F_2$ to give cis-$N_2F_2$ must be conducted at low pressure to avoid decomposition. Both cis-and trans-$N_2F_2$ are inert to water at ambient temperatures but hydrolyze slowly at 74° to

90° C yielding mainly nitrogen, oxygen, and hydrofluoric acid. Only minor amounts of $N_2O$ and $NO_3^-$ are formed. The hydrolytic reactions of the $N_2F_2$ isomers are first order with respect to the nitrogen fluorides. Unlike $NF_3$, cis- and trans-$N_2F_2$ are not hydrolyzed via nucleophilic attack in aqueous solution as shown by the fact that caustic soda does not significantly accelerate the reactions. The mechanism of hydrolysis of cis- and trans-$N_2F_2$ probably involves a bimolecular vapor phase decomposition reaction of the type

$$N_2F_2 + M \rightarrow N_2 + F_2 + M \xrightarrow{H_2O} N_2 + 1/2O_2 + M + 2HF$$

where M = any molecule. No stable intermediates are formed in the hydrolysis reactions of cis- or trans-$N_2F_2$. Author

**N65-13083#** Temple U., Philadelphia, Pa. Research Inst.
**PRODUCTION, ISOLATION AND IDENTIFICATION OF THE OF., $O_2F$. AND $O_3F$. RADICALS Quarterly Progress Report, Jan. 1–Mar. 31, 1964**
A. D. Kirshenbaum and A. V. Grosse [1964] 18 p refs
(Contract AF 04(611)-9555)
(QPR-2; AD-437465)

Discussed is work on the production, isolation, and identification of OF, $O_2F$, and $O_3F$ radicals by (1) bombardment of $O_2BF_4$ with H atoms at 77° K and (2) irradiation of $O_2F_2$, $O_3F_2$, and $O_2BF_4$ with $Co^{60}$ γ-rays at 77° K. Results obtained include the following: The $O_2BF_4$ reacts with H atoms at 77° K to produce $O_3$. The $O_2F_2$ produces two epr signals at 77° K. Irradiated samples of $O_2F_2$ give three epr signals (one plus the two obtained from unirradiated $O_2F_2$). The $O_3F_2$ produces the same two signals as $O_2F_2$—the triplet state signal is twice as strong in pure $O_3F_2$ as in $O_2F_2$ while the hyperfine interaction signal is 50 to 100 times as strong for pure $O_3F_2$ as it is for pure $O_2F_2$. The $O_2BF_4$ is highly paramagnetic. P.V.E.

**N65-13085#** Franklin Inst., Philadelphia, Pa. Labs. for Research and Development
**A STUDY OF SURFACE PHENOMENA ON ORGANIC SOLIDS Quarterly Progress Report No. 1, 10 Jun.–9 Sep. 1964**
P. J. Reucroft, P. Chairge, and M. M. Labes 18 Sep. 1964 16 p refs
(Contract DA-18-035-AMC-141(A))
(Q-B227-1; AD-607028)

A volumetric adsorption system designed to measure adsorption on low specific surface area organic solid powders was constructed and calibrated. Preliminary measurements have indicated that the apparatus is able to measure adsorption onto samples as low as 50 $cm^2$ in area. Author

**N65-13130#** Uppsala U. (Sweden). Quantum Chemistry Group for Research in Atomic, Molecular, and Solid-State Theory
**CHEMICAL SUBSTITUTION TREATED BY PARTITIONING IN THE HUCKEL APPROXIMATION Scientific Report No. 9**
John E. Harriman 15 Jun. 1964 28 p refs
(Contract AF 61(052)-701)
(ARL-65-5; SR-19; AD-608682)

A scheme is presented for the discussion of the effects of chemical substitution on one-electron energies and LCAO molecular orbitals in the simple Hückel approximation. The method is based upon the partitioning of the Hamiltonian matrix corresponding to the physical division of the system into molecule and substituent interacting through one bond. Graphical methods are developed, and a series of hypothetical substituted benzenes are considered as examples. Author

**N65-13140*#** AVCO-Everett Research Lab., Everett, Mass.
**MEASUREMENTS OF THE FREE-BOUND AND FREE-FREE CONTINUA OF NITROGEN, OXYGEN AND AIR**
R. A. Allen, A. Textoris and J. Wilson Sep. 1964 24 p refs
(Contracts NASw-748; AF 29(601)-6488)
(NASA-CR-59824; AVCO-Everett Res. Rept.-195) OTS Prices: HC $1.00/MF $0.50

Measurements have been made of the equilibrium radiation behind incident and reflected shocks produced in an electric arc-driven shock tube over a temperature range of 8000° to 14 000° K. Experiments are described that used a tungsten photoelectric gage to make photometric measurements in the vacuum ultraviolet. This gage was positioned at the axis of the shock tube and cored the oncoming shock wave. By the use of optical stops, this gage was capable of resolving the shock front. A knowledge of the photoelectric yield of the tungsten provided a photometric measurement. The photoionization cross section for the ground-state nitrogen atom was inferred from these measurements to be of the order of $10^{-17} cm^2$. Data were also obtained of the continua at −51μ in nitrogen, oxygen, and air, which gave information on the component of the radiation produced by electrons being captured by ions and neutral atoms. Author

**N65-13145*#** Shell Development Co., Emeryville, Calif.
**DEVELOPMENT OF ANALYTICAL TECHNIQUES FOR HYDROCARBONS IN MINERAL AGGREGATES Quarterly Status Report No. 4, Jul.–Sep. 1964**
D. P. Stevenson and A. G. Polgar [1964] 4 p
(Contract NASw-438)
(NASA-CR-59847; S-13930) OTS Prices: HC $1.00/MF $0.50

The organic chemical content of meteoritic material and of terrestrial rocks spanning a wide geological period is being investigated. A method previously reported for analysis of extraterrestrial material will be used; this method involves Soxhlet extraction of the sample followed by elution chromatography over silica gel with ultraviolet, infrared, and mass spectrometry of the isolated fractions. Methods of preparing the samples for extraction to avoid contamination and changes in molecular nature are discussed. Gas–liquid partition chromatography is also being tested. M.P.G.

**N65-13161#** Victoria U. of Manchester (Gt. Brit.)
**THE THERMOCHEMISTRY OF ALKYLS OF TIN AND GERMANIUM Final Technical Report, Sep. 1963–Sep. 1964**
W. A. Farrar, G. A. Nash, W. F. Stack, and H. A. Skinner 30 Sep. 1964 32 p refs
(Contract DA-91-591-EUC-3095)
(FTR-1; AD-450548)

CONTENTS:

1. HEATS OF REDISTRIBUTION REACTIONS OF TETRA-ALKYLS OF TIN WITH STANNIC CHLORIDE G. A. Nash, H. A. Skinner, and Wallace F. Stack 20 p refs
2. A CYCLIC TETRAMER OF DI-TERT-BUTYLTIN W. V. Farrar and H. A. Skinner 5 p refs
3. HEATS OF COMBUSTION OF METAL ALKYLS 5 p refs

**N65-13167#** Pennsalt Chemicals Corp., King of Prussia, Pa. Research and Development Dept.
**AN INVESTIGATION OF TITANIUM PHTHALOCYANINE POLYMERS**
B. P. Block and E. G. Meloni Oct. 1964 11 p refs
(Contract Nonr-2687(00))
(TR-42; AD-449580)

The $TiCl_3$ and $o\text{-}C_6H_4(CN)_2$ react in refluxing 1-chloronaphthalene under nitrogen to form moisture-sensitive $TiC_{32}H_{16}N_8Cl_2$ ($TiPcCl_2$) in good yield. The chlorides in the product are readily replaced to give $(TiPcO)_x$, an oligomer of $[TiPcOP(C_6H_5)O_2]_x$, and $TiPc[OSi(C_6H_5)_3]_2$, but in refluxing acetic acid only half the chloride is displaced by acetate. These phthalocyanine derivatives of titanium are not exceptionally stable thermally, and the polymer and oligomer are intractable. The infrared spectra of titanium phthalocyanines as a class do not contain characteristic absorption bands. Author

**N65-13198#** Naval Ordnance Lab., Corona, Calif.
**FOUNDATIONAL RESEARCH PROJECTS Quarterly Report, Apr.–Jun. 1964**
1 Sep. 1964 64 p refs
(NAVWEPS-8197; AD-446692)

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1. PERTURBATION THEORETICAL APPROACH TO MAGNETO-OPTICAL PHENOMENA IN THE NONABSORBING REGION A. Nedoluha p 1–16 refs (See N65-13199 03-26)

2. AN EXPERIMENTAL VLF DIPOLE TRAVERSING AN ISLAND E. W. Seeley, P. E. Tallant, and I. Rainwater p 17–37 refs (See N65-13200 03-07)

3. INFRARED ABSORPTION SPECTRUM OF $Pr^{3+}$ IN $LaF_3$ R. A. Buchanan and H. H. Caspers 39–54 refs (See N65-13201 03-06)

4. SPECTRAL EMITTANCE OF InAs D. L. Stierwalt and R. F. Potter p 55–64 refs (See N65-13202 03-06)

**N65-13201#** Naval Ordnance Lab., Corona, Calif. Infrared Div.
**INFRARED ABSORPTION SPECTRUM OF $Pr^{3+}$ IN $LaF^3$**
R. A. Buchanan and H. H. Caspers *In its* Foundational Res. Proj. 1 Sep. 1964 p 39–54 refs (See N65-13198 03-06)

The near-infrared absorption spectrum from 1 to 6 $\mu$ of $Pr^{3+}$ in $LaF_3$ is reported. Many of the levels previously observed by another author were also observed here. Some new levels were found, and, in particular, the Stark split levels of $^3F_3$ are reported. In addition, $LaF_3$ lattice vibrations were observed coupling to the Stark split $^3H_5$ and $^3F_4$ electronic transitions. Experimental conditions, methods, and data are presented, along with several spectral curves and tables. D.E.W.

**N65-13202#** Naval Ordnance Lab., Corona, Calif. Infrared Div.
**SPECTRAL EMITTANCE OF InAs**
D. L. Stierwalt and R. F. Potter *In its* Foundational Res. Proj. 1 Sep. 1964 p 55–64 refs (See N65-13198 03-06)

Infrared absorption spectra were determined for InAs by measuring the spectral emittance of the sample at temperatures of 77°, 203°, and 373° K. Experimental details are given. Results are displayed graphically, and measurements and formulas are given and discussed. D.E.W.

**N65-13284*#** California U., Berkeley. Aeronautical Sciences Lab.
**THE STUDY OF BASE HEATING BY RADIATION FROM EXHAUST GASES Final Report, Oct. 1, 1963–Sep. 30, 1964**
W. H. Giedt, C. L. Tien, R. N. Meroney, M. M. Abu-Romia, and L. S. Wang 20 Oct. 1964 50 p refs
(Contract NAS8-850)
(NASA-CR-59899) OTS Prices: HC $2.00/MF $0.50

Analytical studies were made on the radiative energy transfer from an exhaust plume to the base region of a booster vehicle. Problems of semi-infinite cylindrical and infinite conical gas bodies of uniform temperature and composition are considered. Also included is the calculation of the spectral apparent emissivity of a gas body as viewed from the bore region for the case of a semi-infinite cylindrical plume. An approximate method of calculating the total apparent emissivity based on the mean-path-length concept was developed and applied to the calculations in the case of semi-infinite cylindrical gas bodies composed of $CO_2$ at 2500° R and $H_2O$ at 2000° R. The infrared spectral characteristics of a number of combustion products under a variety of thermodynamic and optical conditions were also studied. A graphite resistance furnace for infrared spectral absorption studies up to temperatures of about 2000° K was constructed, and used to obtain data for CO at temperatures of 300° and 1800° K at pressures from 0.25 to 3.0 atm. Comparison with existing experimental data showed agreement within 15 percent. G.G.

**N65-13295#** Pennsylvania U., Philadelphia.
**CALCULATION OF MAGNETIC PROPERTIES OF MOLECULES**
H. F. Hameka [1964] 5 p ref
(Contract DA-31-124-ARO(D)-25)
(AROD-3967-3; AD-451542)

A general method of calculating the magnetic susceptibilities of diatomic molecules was developed, and reasonable results were obtained through its application. An analogous method to evaluate the magnetic shielding constants for diatomic molecules is proposed. It was found that the derivation of the theories of magnetic properties from simple observations is not justified because they are based on incorrect approximations. A theory for magnetic rotation spectra with emphasis on particular optical rotation and resonance fluorescence phenomena was developed, and some work on bond angle calculations for aromatic six member heterocycles was performed. G.G.

**N65-13297*#** California U., Berkeley.
**REVIEW OF EMISSIVITY CALCULATIONS FOR DIATOMIC GASES First Quarterly Progress Report, 29 Jun.–28 Sep. 1964**
Ralph Greif 13 Oct. 1964 29 p refs
(Contract NAS8-11468)
(NASA-CR-59830) OTS Prices: HC $2.00/MF $0.50

Expressions are derived for the absorption or emission spectra of rotating diatomic molecules and vibrating diatomic molecules, and a comparison is made with the coarse structure of the observed spectrum. It is concluded that the observed spectrum in the far infrared consists of a series of nearly equidistant lines and is therefore primarily a rotation spectrum; in the near infrared, it consists essentially of a single intense line and is therefore a vibration spectrum. Representations of fine structure of the infrared spectrum are given for an anharmonic oscillator, the nonrigid rotator, and the vibrating rotator. To calculate the absorption of a band, several band models are considered, the regions of validity for absorption calculations are discussed, and emissivity calculations presented. D.S.G.

**N65-13328*#** Geophysics Corp. of America, Bedford, Mass.
**PLANETARY PHYSICS VIII: REACTIONS OF $^1D$ OXYGEN ATOMS IN THE PHOTOLYSIS OF CARBON DIOXIDE. II**
Peter Warneck Oct. 1964 16 p refs
(Contract NASw-840)
(NASA-CR-57019; GCA-TR-64-15-N) OTS Prices: HC $1.00/MF $0.50

The vacuum uv photolysis of $CO_2$ containing initially no oxygen was investigated in a closed system, and the quantum yields of ozone and oxygen were determined. The quantum yield for ozone production was found to be below $Q(O_3)<0.03$, which is insufficient to explain the oxygen deficiency observed in the $O_2$ quantum yields. The $(O_2)/(CO)$ ratio was found to depend on the light intensity, on the time interval after which an irradiated sample was subjected to analysis, and on the ratio of carbon dioxide to admixed rare gas concentration. The results concerning the $(O_2)/(CO)$ ratio can be explained by the formation of $CO_3$ due to the attachment of $^1D$ oxygen atoms to $CO_2$. This reaction is in competition with the third body recombination of $^1D$ oxygen atoms. Author

**N65-13337#** Monsanto Research Corp., Dayton, Ohio. Dayton Lab.
**THE INFRARED SPECTRA OF SELECTED ALIPHATIC AMIDES BETWEEN 700–250 $cm^{-1}$**
J. V. Pustinger, W. R. Feairheller, Jr., and J. E. Katon [1964] 36 p refs
(Contract AF 33(616)-8465)
(AD-607211) OTS: $2.00

Spectral data for 78 amides were recorded from 700 to 250 $cm^{-1}$ and analyzed for spectra-structure correlations. The information obtained can be used in identification of these compounds. The spectra were found to be very rich in absorption bands, and thus they would be useful in "fingerprint" characterization when used in conjunction with the 4000 to 700 $cm^{-1}$ region. Some new group frequencies have been observed, and their assignments are discussed and compared with assignments previously published. A comparison of the C—C=O deformation frequencies of amides with that of acids, aldehydes and ketones is made. It is shown that this vibration gives rise to a good group frequency in all of these classes. Author

# 07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

**N65-12344#** Weapons Research Establishment (Australia).
**SHORT AND MEDIUM LENGTH YAGI ARRAYS**
H. E. Green Jun. 1964 59 p refs
(PAD-13)

This paper theoretically treats uniform and tapered Yagi arrays of between 2 and 10 elements and arrays of these arrays by the classical coupled circuit method. The result is the derivation of extensive tabulated design data, especially for the uniform Yagi array. A further section of the paper considers the question of the bandwidth of Yagi arrays. Considerable experimental work has been done to support the theoretical work and is described. Author

**N65-12437#** ADCOM, Inc., Cambridge, Mass.
**CHARACTERIZATION OF RADIO CHANNELS Interim Report, 15 Mar.–1 Jul. 1964**
Arthur Krinitz [1964] 457 p refs
(Contract DA-28-043-AMC-00038(E))
(AD-448484)

This study presents the channel characteristics in terms of their effect on the transmitted signal or signals, in order to form a basis for analytical studies and performance predictions of communications systems. The study is also used for the interpretation of the observed performance of communications systems over the different channels, and for the exploitation of channel characteristics to combat specific types of interference. G.G.

**N65-12451#** Army Signal Radio Propagation Agency, Fort Monmouth, N.J.
**AVAILABLE-POWER CALIBRATION OF RECEIVING SYSTEMS FOR RADIO-PROPAGATION MEASUREMENTS**
Richard Silberstein 5 Jun. 1964 20 p refs
(AD-603773)

The available-power concept lends itself readily to the calibration of recording receivers used for amplitude measurements where the receiver is not in general matched to the rf input cable. When the antenna is matched to the cable, valid calibrations can be had by calibrating with a signal generator matched to the characteristic impedance of its cable, assumed to be the same as that for the antenna cable. This is true even when the antenna cable has some losses that, if added to the available power measured at the receiver end, are the cable losses for the matched case. If the antenna is not matched to the cable, it is shown that the available power can be measured by first matching the receiver end of the cable to the cable characteristic impedance and then using the system with this matching network feeding the receiver. Cable loss must be determined for the system in the matched condition, and extra losses, which are frequently negligible, must be added for the antenna mismatch. Author

**N65-12452#** RAND Corp., Santa Monica, Calif.
**SOME TOPICS IN SEQUENTIAL DETECTION AND ESTIMATION**
Ivan Selin Feb. 1963 13 p refs Presented at the Los Angeles Chapter, Profess. Group on Inform. Theory, IEEE, 26 Feb. 1963
(P-2711)

Radar implications of sequential detection and estimation are discussed, particularly the sequential test of a simple hypothesis versus a single alternative, the sequential test for the presence of a signal of unknown range or velocity, and the sequential estimation of radar parameters. P.V.E.

**N65-12459#** Naval Ordnance Lab., Corona, Calif. Research Dept.
**AN EXPERIMENTAL VLF DIPOLE TRAVERSING AN ISLAND**
E. W. Seeley, P. E. Tallant, and I. E. Rainwater 1 Sep. 1964 23 p refs
(NOLC-607; AD-447871)

A wire was laid across San Nicolas Island and fed with vlf energy at its center. From the results of measurements, it was concluded that the island antenna performed as a horizontal dipole, not as a slot antenna. Several antenna parameters were measured—input impedance, efficiency, radiated field intensity at a receiving site 252 km away, antenna current distribution, bandwidth, radiated power, effective height, and soil conductivity. It was also concluded that, if the antenna current distribution is the same, there is no improvement in radiated power when the antenna is elevated a few feet, when compared with its lying on the ground. Methods of improving the antenna efficiency are outlined. Author

**N65-12481#** Radio Corp., of America, Camden, N.J. Defense Electronic Products

**REVISIONS TO RELIABILITY PROGRAM PLAN X-20 (DYNA-SOAR). COMMUNICATIONS AND TRACKING SUBSYSTEM**

21 Jan. 1963 49 p
(Contract AF 33(657)-7134)
(AD-448891)

This document describes the management organization that has been established to direct the reliability program; defines the detailed reliability tasks; establishes program milestones; and describes the controls that are used to insure satisfactory completion of each task on schedule. Author

**N65-12489#** Aerospace Corp., El Segundo, Calif. El Segundo Technical Operations

**TRACKING, TELEMETRY, AND COMMAND STUDIES OF GROUND AND SATELLITE SUBSYSTEMS. VOLUME VI: PARAMETRIC ANALYSIS OF TRACKING, TELEMETRY, AND COMMAND SUBSYSTEMS**

D. Matson May 1964 207 p refs
(Contract AF 04(695)-269)
(TDR-269(4110-01)-13, Vol. VI; SSD-TDR-63-334, Vol. VI; AD-450849)

The tracking, telemetry, and command subsystems are analyzed and discussed relative to those factors that affect required system power, bandwidth, and flexibility of application. The space–ground link system (SGLS) requirements implicitly form the basic background of specifications to be fulfilled by the system under discussion. Except for restriction to a range tone subsystem, these requirements do not restrict the system capability, inasmuch as the system must service a broad spectrum of satellite missions. The overall system problem is discussed from the standpoint of multiplexing the service signals upon the communications channel. The various forms of single- and multiple-carrier channels, with and without subcarriers, are considered. Author

**N65-12519#** Philco Corp., Palo Alto, Calif. Western Development Labs.

**RELIABILITY MONITORING POINTS AND QUARTERLY REVIEW REPORT Contract Status Report, Jul.–Nov. 1962**

11 Jan. 1963 69 p refs
(Contracts AF 04(647)-532; AF 04(647)-829)
(WDL-TR1990; AD-444717)

Major reliability activities are shown on milestone charts and are discussed for vehicle communications and ground-equipment components. Reliability problems and problem areas are pointed out, and failure summaries are presented. M.P.G.

**N65-12537#** Pacific Naval Lab., Esquimalt (Canada).

**ON THE SUITABILITY OF ARCTIC SEA ICE AS A PLATFORM FOR MEASURING ELECTROMAGNETIC BACKGROUND AT MICROPULSATION AND EXTREMELY LOW FREQUENCIES**

J. A. Shand Aug. 1964 14 p refs
(PNL-TM-64-7; AD-449826)

The feasibility was investigated of making reliable magnetic component measurements on sea ice of the micropulsation and ELF background in the frequency range between about 0.02 and 80 cps. Metal-cored solenoid detectors and battery-operated electronics yielded a data record on magnetic tape, a portion of which was compared with simultaneous data from the other Canadian stations. The experiment included successive measurements at 2 sites, one on 3-meter thick ice facing the Arctic Ocean and another on 2-meter thick ice in an inland passage. The records indicate that shore-fast ice, 2-meters in thickness, is an adequately stable platform during calm weather conditions, while the 3-meters ice remains stable even in winds of 15-meters/sec. Author

**N65-12540#** Joint Publications Research Service, Washington, D.C.

**RADAR APPARATUS FOR POLARIZATION INVESTIGATIONS OF CLOUDS AND PRECIPITATION**

S. P. Morgunov, G. P. Trifonov, and A. B. Shupyatskiy 14 Dec. 1964 10 p refs Transl. into ENGLISH from Tr. Tsentr. Aerolog. Observ. (Moscow), no. 48, Oct. 1964 p 106–111
(JPRS-27828; TT-64-51933) OTS: $1.00

A radar system used to investigate the polarization of echo signals from clouds and precipitation is described. The system consists of a stationary two-antenna radar station with a fixed beam and variable polarization. A separate polarization converter is provided for an expeditionary station with a moveable single transmitting and receiving antenna. Both stations can radiate and receive echo signals with plane, circular, or elliptical polarization. A block diagram of the system is presented, and the development of the polarization converter consisting of rotatable quarter-wave array near the radiating horn is discussed. Operating parameters have been selected experimentally to give the optimum circular polarization compatible with satisfactory watching with the entire radiating system. M.P.G.

**N65-12550#** Alaska U., College. Geophysical Inst.

**HF/VHF AURORAL AND POLAR ZONE FORWARD SOUNDINGS**

H. F. Bates and R. D. Hunsucker May 1964 23 p refs *Its* Sci. Rept.-3
(UAG-R150)

Preliminary forward sounding results obtained during the winter 1963–1964 at College, Alaska, are presented and analyzed to determine the seasonal variation of the sporadic-E and delayed or off-path modes on both polar and nonpolar propagation paths. It appears that during the winter months at sunspot minimum polar hf propagation is predominantly supported by sporadic-E ionization; the transition from winter "night modes" (sporadic-E) to F-propagated "day modes" occurs about the middle of February. The results also confirm the existence of long delayed or off-path modes on polar and nonpolar hf propagation paths. The high percentage of sporadic-E propagation (over 50% on Thule College and Andoya College circuits) and the typical maximum observed frequencies (MOF) of 16 to 18 Mc/sec suggest that long range hf traffic may be routed over polar paths during winter-night sunspot-minimum periods when the midlatitude MOF's are quite low. M.P.G.

**N65-12551#** Motorola, Inc., Scottsdale, Ariz. Military Electronics Div.

**STUDY PROGRAM USE OF THE AN/DPN-66 TRANSPONDER IN A RANGE CALIBRATION SATELLITE Final Report**

F. Sharp 21 Nov. 1963 169 p refs
(AFCRL-63-912; AD-426345)

The performance characteristics of the transponder AN/DPN-66 were investigated to see if it could be modified to serve as a C-band transponder in a range calibration satellite.

Electromagnetic compatibility tests showed that the modified transponder could be used for satellite application. The following areas of investigation are summarized: (1) power-line voltage limits; (2) radiation effects on semiconductors; (3) reliability analysis; (4) semiconductor conformance to specification; (5) pressure relief valve; (6) field-test equipment and procedures; and (7) antenna and propagation studies. R.V.E.

**N65-12554#** Spacelabs, Inc., Van Nuys, Calif.
**INVESTIGATION OF DIPLEXING TRANSDUCERS FOR VOICE COMMUNICATIONS Final Report, 1 Jan. 1962–28 Feb. 1963**
Alan Dale Bredon Wright-Patterson AFB, Ohio, ASD, Feb. 1963 63 p refs
(Contract AF 33(657)-7751)
(SR62-1048; ASD-TDR-63-157; AD-400487)

The physiological problems relating to the wearing of communications microphones and headsets by personnel in aerospace vehicles are defined in this report. Methods of providing full diplex voice communication with a single dual-purpose transducer are discussed. Air conduction, bone conduction, electrophonic phenomena, and direct radio-frequency stimulation for the purpose of communication are considered in this study. An ear canal insert diplexer system (dual-purpose transducer) is found, through research and direct experiment, to yield good intelligibility without interfering with other body functions. A superaudible chopper diplexing method is also selected as a promising technique for utilization of a dual-purpose transducer. The use of the proposed systems in aerospace vehicles for extended periods is found to be entirely feasible. Author

**N65-12563#** Aerospace Corp., El Segundo, Calif. Laboratory Operations
**ELECTRONICS PROGRAM: RADIO FREQUENCY INTERFERENCE AT ORBITAL ALTITUDES Semiannual Technical Report, 1 Jan.–30 Jun. 1964**
K. H. Hurlbut and C. J. Zamites 30 Oct. 1964 28 p refs
(Contract AF 04(695)-269)
(SSD-TDR-64-246; TDR-269(4250-44)-2; AD-452080)

Investigation of radio-frequency interference (RFI) at orbital altitudes was initiated because of the lack of information and effort essential for future reliable communications in space. Higher and higher transmitting powers and more crowded frequency bands are responsible for ever-increasing RFI problems that demand solution. The objectives were to study the RFI problem and to investigate the design of monitoring instruments suitable for making in-space measurements of the electromagnetic environment. Laboratory development of a compact, lightweight, receiving system in the 200- to 1000-Mc-band was initiated. The receiving system is to consist of an antenna array, a bank of interdigital bandpass filters, and 16 crystal video receivers. The results of tests on breadboard and prototype circuits demonstrated the feasibility of this instrumentation concept. Author

**N65-12575#** Navy Electronics Lab., San Diego, Calif.
**ELECTROMAGNETIC FIELD STRENGTH MEASUREMENTS AT 10.2 KILOCYCLES PER SECOND Research Report, Aug. 1962–Feb. 1964**
E. R. Swanson 17 Sep. 1964 35 p refs
(NEL-1239; AD-450739)

Measurements of vlf signal amplitude received over various paths are presented and analyzed. Expressions and attenuation rates are given to compute the amplitude of a signal received over any temperate latitude path during either day or night. The standard deviation of the received amplitude was found to be about 1.6 dB. No significant correlation of the fluctuations was observed, nor was any significant seasonal effect noted. A very significant fade was found over all temperate latitude paths at sunrise. Some comments on Arctic transmission are made. Author

**N65-12605*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**ELECTRONICALLY STEERABLE ANTENNAS FOR COMMUNICATION SATELLITES**
Dennis L. Backus Oct. 1964 15 p refs Presented at the 8th Intern. Conv. on Mil. Electron., Mil-E-Con 8, Washington, 16 Sep. 1964
(NASA-TM-X-55106; X-625-64-208) OTS Prices: HC $1.00/MF $0.50

This paper presents several electronically steerable antenna techniques which, for frequencies from 1 to 35 Gc, show promise for application to communications satellites. Selected beam forming techniques are presented, and many steerable antenna designs are derived from these basic techniques. An examination of the circuitry required to implement the design is utilized to prove that the antenna is no longer solely an input or output to a given system but becomes now an inseparable part of the system. Basic problem areas of beam forming, self tracking, and scanning are outlined. Several promising techniques, namely the retrodirective and transdirective, are applied to earth–space–earth and space–space communication links. Author

**N65-12656#** Lincoln Lab., Mass. Inst. of Tech., Lexington.
**HAYSTACK POINTING SYSTEM: STARS Group Report 1964–47**
H. E. Frachtman 25 Sep. 1964 65 p refs
(Contract AF 19(628)-500)
(ESD-TDR-64-380; AD-449739)

STARTRACK is a program in the Haystack Univac 490 pointing system whose output is the celestial coordinates of a given star at a specified time. The program computes the coordinates from the stated epoch to the beginning of the current solar year and then computing the apparent coordinates from the updated mean coordinates using the Besselian day number procedure. If the star has a declination greater than 77°, an additional correction for diurnal aberration is made in right ascension. Author

**N65-12669#** Applied Physics Lab., Johns Hopkins U., Silver Spring, Md.
**GENERAL PURPOSE ANTENNA POINTER**
E. E. Westerfield Aug. 1964 95 p refs
(Contract NOw-62-0604-c)
(TG-600; AD-450034)

The general-purpose antenna pointer utilizes a punched paper tape, containing precomputed pointing data, as the source of input data. Either the data may be computed for a specific pass, or a generalized form of tape may be generated. The antenna pointer consists essentially of a paper-tape reader, two buffers, and a digital-to-analog converter. The paper tape is read one digit at a time into the first buffer until it contains a complete time frame. The data are then shifted to the second buffer—part of a digital-to-analog converter—that points the antenna by utilizing analog techniques. Details of the circuitry utilized for the antenna pointer are given, and program listings for the 7094 and 1401 programs used in generating the input data are presented, along with a discussion of the tape format for the antenna pointer. P.V.E.

**N65-12671#** Naval Research Lab., Washington, D.C. Radar Div.

**A FIXED-ARRAY, HIGH-DATA-RATE, SEARCH AND HEIGHT-FINDING RADAR. PART 3: THE BEAM PROGRAMMER**

W. H. Harper 9 Sep. 1964 29 p refs

(NRL-6143; AD-449627)

A solid-state beam programer has been designed, assembled, and integrated into an experimental fixed-array radar. Germanium transistor plug-in circuit modules have been used in circuits that required a minimum of design and assembly time. The operation of the circuit modules individually and in the circuits of the programer is discussed. Triggers are developed in the proper time sequence for the origination of rf pulses, receiver displays, and high-voltage-modulator pulses. Waveforms are generated for biasing microwave diodes in the proper manner so as to sweep a quadrant of space with the transmit and receive beams at intervals of 0.5, 1.0, 2.0, and 4.0 seconds. Automatic or manual sweep modes are optional with this unit. A staircase waveform with sawtooth waveforms added to each step is generated to drive the azimuth sweep circuits of a B-scope. Indicator circuits have been incorporated that drive neon beam-position indicators. Author

**N65-12754#** General Motors Corp., Santa Barbara, Calif. Aerospace Operations Dept.

**ELECTROMAGNETIC WAVE SCATTERING FROM DIELECTRIC-COATED METAL BODIES**

Henry M. Musal, Jr. Aug. 1964 24 p refs

(Contract DA-04-495-ORD-3567; ARPA Order 357-63; Proj. Defender)

(CTN64-05; AD-448062)

The general definition of the radar cross section of a body including the electromagnetic field intensities of the incident and scattered waves, is reviewed. It is shown how the scattered wave is determined by the induced electromagnetic field at the surface of the body, caused by the incident electromagnetic wave. The physical optics approach that relates the induced electromagnetic field to the incident electromagnetic wave at the surface of the body is reviewed, and the resultant radar cross-section formula is given. The modification of this approach that accounts for the phase and amplitude perturbations caused by a thin dielectric coating over the metal surface is presented, and the resultant formula for the radar cross section is then derived. Author

**N65-12757#** General Motors Corp., Santa Barbara, Calif. Aerospace Operations Dept.

**CW OBLIQUE RADAR FOR STUDYING THE SCATTERING CHARACTERISTICS OF IONIZED WAKES. I: 35-Gc RADAR WITHOUT SEPARATE PHASE- AND AMPLITUDE-MEASURING CAPABILITIES**

Paul Robillard Oct. 1964 24 p ref

(Contract DA-01-021-AMC-11359(Z); ARPA Order 357-63; Proj. Defender)

(CTN64-11; AD-450192)

Initial observations made with the 35-Gc oblique radar show that strong signals can be detected from wakes produced by hypersonic projectiles fired on a free-flight range. Firings of spheres and cones have been observed with both low- and high-resolution antennas, and wake transition has been detected with the high-resolution antenna. Data previously obtained with a simple cw doppler radar are being used as a guide in improving the oblique radar. M.P.G.

**N65-12759#** Philco Corp., Palo Alto, Calif. Western Development Labs.

**GROUND RADOME STUDY Final Report**

1 Dec. 1962 133 p refs

(Contract AF 04(695)-113)

(WDL-TR1936; AD-292789)

This report reviews the present state-of-the-art in the design and analysis of large ground radomes. It provides information and results that may be used to evaluate and improve the performance of existing radomes and of future advanced radome designs. Considerations are given to the structural, electrical, environmental, and material performance of various types of radomes. Author

**N65-12773#** Joint Publications Research Service, Washington, D.C.

**GRAPHICAL-ANALYTICAL METHOD FOR CALCULATION OF RADIO COMMUNICATION LINES**

Sh. G. Shlionskiy 15 Dec. 1964 13 p refs Transl. into ENGLISH from Tr. IZMIRAN, Akad. Nauk SSSR, v. 29, no. 19, 1961 p 131–139

(JPRS-27852; TT-64-51944) OTS: $1.00

A method of graphic-analytic calculation of minimum useable frequencies (LUF), maximum communication range ($R_{max}$), minimum necessary transmitter power ($P_{nec}$), and other values of importance in planning radio communication lines is presented. The computations are carried out with regard to parameters of the technical facilities. The equation derived for the condition of communications is $[E^{(1)}_{sig}] = T + [E^{(1)}_{int}]$, where $E^{(1)}_{sig}$ is the signal field strength when the radiated effective power is 1 kW, T is the technical factor, and $E^{(1)}_{int}$ is the interference field strength with a passband width of 1 kc. A method of solving the equation by a series of graphic representations of the different variables involved is presented, and the accuracy of the method is discussed. M.P.G.

**N65-12814*#** Aero Geo Astro Corp., Alexandria, Va.

**A STUDY OF TECHNIQUES FOR REDUCING THE NOISE TEMPERATURE OF PASSIVE PARABOLOIDAL REFLECTOR ANTENNAS Final Report**

K. D. Mc Donald Oct. 1962 239 p refs

(Contract NAS5-1951; ASA Proj. 1196)

(NASA-CR-60035) OTS Prices: HC $6.00/MF $1.25

Results of this study include presentation and analysis of the basic physical factors influencing the effective noise temperature of passive paraboloidal reflector antennas; description of a novel shaped beam "fluted feed" surface-wave structure capable of improving conventional paraboloidal antenna low-noise performance by a factor of between two and five; and presentation of design information and experimental results for a completely new Cassegrainian sectoral horn-reflector antenna that is physically compact, attains an equivalent antenna noise temperature of less than five degrees Kelvin, and appears in nearly all respects to be superior to all other low-noise antennas currently available. A discussion of external noise sources is presented including contributions due to galactic radiation, atmospheric absorption, ground radiation, and various other influences. Author

**N65-12822#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering

**A DIGITAL SIMULATION FOR THE PROPAGATION OF ELECTROMAGNETIC ENERGY THROUGH A STRATIFIED MEDIUM**

Walter S. Greenwood, Jr. (M.S. Thesis) Aug. 1964 85 p refs

(GA-64; AD-607030) OTS: $3.00

A mathematical model is described that simulates the propagation of electromagnetic energy through a stratified medium. The model was applied mainly to atmospheric conditions, although it is very general in nature and can be applied to propagation through any stratified medium. The basic equations are derived, and the application to the digital computer is shown. The particular problem areas of constant phase, critical angle, and energy distribution are discussed. The final form of the computer program is given, showing the types of inputs, the procedure followed in the program, and the outputs obtained. Results are discussed, and it is concluded that the model accurately describes the propagation of electromagnetic energy through a stratified medium in the area included in the refractive index profile used as the input. D.E.W.

**N65-12844#** Holmes and Narver, Inc., Los Angeles, Calif.
**MODEL STUDIES OF THE VLF PAC ANTENNA**
12 Apr. 1963 127 p ref A joint venture with Continental Electron. Mfg. Co. and DECO Electron., Inc.
(Contract NBY-37636)
(AD-406320)

A scale-model study of a high-power, very-low-frequency transmitting antenna was made in order to gain electrical-performance data for evaluation and for subsequent modifications leading to a final design. A table is presented that summarizes both the predicted full-scale basic antenna parameters and the derived operating characteristics, relating both to the full-power operation at the design frequency. The normal and the wind-distorted data were obtained from the final model. It was concluded that the selected configuration adequately meets the design goals. G.G.

**N65-12858#** Gt. Brit. Dept. of Scientific and Industrial Research. Radio Research Station
**OPTICAL OBSERVATIONS OF SATELLITES RECEIVED BY THE PREDICTION SERVICE FOR THE MONTH OF JUNE 1964**
[1964] 27 p

Observations from COSPAR stations of the time, right ascension, declination, and magnitude of various orbiting objects are tabulated. These data are presented, in order of launch, for Explorer 7, TIROS 1, TIROS 2, Transit 1B, Sputnik 4 cabin; Samos 2, Samos 2 nosecap, Midas 3, Ariel 1, Midas 5; TIROS 6, Alouette 1, the Alouette 1 rocket; Anna 1B rocket, Explorer 16, Explorer 17, Poltet 1, Centaur 2, Explorer 19; the TIROS 8 rocket, Echo 2, the Echo 2 rocket, an Echo 2 fragment, Electron 1, Cosmos 25, the Cosmos 25 rocket, Ariel 2, Poltet 2, Cosmos 31, and the Cosmos 31 rocket, as well as for unnamed orbital objects designated as 1962 Alpha Upsilon-1; 1963-14A; 1962 Beta Kappa-1; 1963-30A, -30D, -42B, -49A, -49C, and -55B; and 1964-01A and -31A. D.E.W.

**N65-12859#** Gt. Brit. Dept. of Scientific and Industrial Research. Radio Research Station
**OPTICAL OBSERVATIONS OF SATELLITES RECEIVED BY THE PREDICTION SERVICE FOR THE MONTH OF JULY 1964**
[1964] 27 p

Observations from COSPAR stations of the time, right ascension, declination, and magnitude of various orbiting objects are tabulated. Orbital objects listed include Sputnik 4 cabin, Transit 2A, the Transit 2A rocket, TIROS 2, the Echo 1 rocket, Explorer 8, SAMOS 2, Transit 4A, Midas 3, TIROS 4, TIROS 5, TIROS 6, Alouette 1, the Alouette 1 rocket, the Injun 3 rocket, Midas 4, the Anna 1B rocket, Cosmos 17, TIROS 7, the Geophysics Research Satellite, Explorer 19, TIROS 8, the TIROS 8 rocket, Polyot 1, Echo 2, the Echo 2 rocket, Electron 1, Cosmos 25, Cosmos 26, Ariel 2, the Ariel 2 rocket, Cosmos 31, the Cosmos 31 rocket, Starflash, Cosmos 34, the Cosmos 34 rocket, Electron 3, as well as unnamed orbital objects identified as 1963-03A, -27A, -30A, -30D, -49A, -49B, -49C, and -55B; and 1964-01A, -01B, -01C, -01D, -01E, -04E, -11A, -31A, -31B, -32A, -36A, and -36B. D.E.W.

**N65-12872#** Joint Publications Research Service, Washington, D.C.
**OBSERVATIONS IN POLAND OF ARTIFICIAL EARTH SATELLITES**
Ludoslaw Cichowicz 3 Dec. 1964 9 p ref Transl. into ENGLISH from Nauka Polska (Warsaw), no. 4, Jul.–Aug. 1964 p 186–192
(JPRS-27667; TT-64-51857) OTS: $1.00

Twelve Polish satellite observation stations and the work done at each are described. A short history from the first Polish observations in 1957 to the year 1964 is presented, and the multilateral exchange of astronomical data with Viet Nam, Bulgaria, and other so-called socialistic democratic scientists is pointed out. G.G.

**N65-12889#** Harvard U., Cambridge, Mass. Cruft Lab.
**CONDITIONS FOR OPTIMUM DIGITAL COMMUNICATION WITH APPLICATION TO DELTA MODULATION**
Terrence Fine 5 Mar. 1963 45 p refs
(Contract Nonr-1866(16))
(TR-399; AD-405053)

A procedure for optimization of a class of binary communication systems is presented and applied. The message set, or transmitter input, is taken to be a real valued sample sequence from a stochastic process with discrete parameter. The transmitter may be any time-varying, nonlinear operator with domain of the real valued input and range to the binary numbers. The transmission medium or noisy channel linking the transmitter and receiver is to be characterized by the conditional probabilities of all possible received binary sequences given any transmitted sequence. The receiver may be any real valued, time-varying, nonlinear operator on the received binary sequences. Author

**N65-12957#** Weapons Research Establishment (Australia).
**TABLES OF WAVELENGTHS FOR U.S. ARMED SERVICES APPROVED CYLINDRICAL WAVEGUIDES CARRYING THE $H_{11}(TE_{11})$ MODE OF PROPAGATION**
J. R. Pyle Apr. 1964 124 p refs
(WRE-TN-PAD-85)

Wavelengths for the dominant $H_{11}$ mode in cylindrical waveguides were computed for 22 sizes of waveguide covering the frequency band 2830 Mc/sec to 87 200 Mc/sec. Author

**N65-12959#** Harvard U., Cambridge, Mass. Cruft Lab.
**A STUDY OF CIRCULAR ARRAYS. 2: SELF AND MUTUAL ADMITTANCES**
Richard B. Mack 1 May 1963 117 p refs
(Contract Nonr-1866(32))
(TR-382; AD-417616)

The measured self and mutual admittances of a single antenna and of circular arrays of from two to five identical, nonstaggered elements are compared with corresponding quasi-zeroth- or quasi-first-order theoretical values for dipole lengths $2h/\lambda = 0.5000, 0.7500, 1.0000, 1.2500$, and 1.5000. All results are for a constant dipole radius of $a/\lambda = 0.007022$. An array of N antennas is assumed to have the

antennas at the corners of an N-sided equilateral polygon of side $d/\lambda$, and $d/\lambda$ ranged from 0.1250 to 0.8750 for N = 5, to 1.000 for N = 4 and 3, and to 1.6000 for N = 2. Experimental and theoretical values of the self-conductances and mutual admittances are found to be in good agreement for $h/\lambda < 0.6000$. Theoretical and experimental self-susceptances have the correct variation with $d/\lambda$ but differ in actual value. Also, resonant spacings are found at which the conductances are all high and the susceptances are zero or very nearly zero. Author

**N65-12960#** Harvard U., Cambridge, Mass. Cruft Lab.
**A STUDY OF CIRCULAR ARRAYS. 6: PLAN FOR PRACTICAL APPLICATION TO ARRAYS OF TWENTY OR FEWER ELEMENTS**
Richard B. Mack and Evelyn W. Mack 1 May 1963 68 p refs
(Contract Nonr-1866(32))
(TR-386; AD-425554)

The quasi-zeroth-order theory of linear antennas is presented in a form for engineering applications, which avoids intricate mathematical details. The theory is packaged as a FORTRAN II program that computes radiation patterns, admittances, and current distributions of an array of dipoles or monopoles, which are spaced so that they divide the circumference of a circle into an even number of parts. The user need only supply input data cards to the program. Author

**N65-13002#** Aeronca Mfg. Corp., Middletown, Ohio.
**INVESTIGATION OF FOAM PLASTIC TECHNIQUES FOR HARDENING GROUND RADOMES Final Report, 1 Jul. 1963–31 MAY 1964**
R. R. Jeffries and B. B. Cahill Griffiss AFB, N.Y., RADC, Oct. 1964 247 p
(Contract AF 30(602)-3128)
(RADC-TDR-64-363; AD-608473)

The effectiveness of a foam-plastic antenna protection system in atomic blast was investigated. Conclusions were summarized as follows: (1) The nuclear radiation will have a negligible effect on the dielectric and mechanical properties. (2) Thermal radiation produces considerable physical changes in all foam-plastic materials through ablation, burning and melting. The electrical properties of most foam plastics are affected as a result of charred composites on the residual surface. However, polyethylene foam was observed in thermal ablation tests to leave no charry residue. A thermal protection system using a polyethylene foam laminate was concluded feasible. (3) Mechanical shock effects due to the blast overpressure wave were inconclusive. Tests indicate that phase errors are the main contributors to degradation of the pattern, and these should be eliminated if possible by a symmetrical assembly. The attenuation and reflection losses in low density foam were small. Boresight shift was observed and agreed well with the calculated value. Author

**N65-13003#** General Dynamics/Fort Worth, Tex.
**RADAR CROSS SECTION TARGET SUPPORTS—PLASTIC MATERIALS Report No. 6**
C. H. Smith, C. C. Freeny, E. F. Knott, and T. B. A. Senior Griffiss AFB, N.Y., RADC, Jun. 1964 134 p refs
(Contract AF 30(602)-2831)
(FZE-222-6; RADC-TDR-64-381; AD-608252)

The results of studies into the scattering properties of cellular plastic materials are presented. A mathematical model for scattering from cellular plastics to provide a method of determining the optimum low-cross-section target support for a given application is also presented. The results of investigations of field perturbations near a Styrofoam surface are described, along with cross-section measurements made at the RAT SCAT site using theoretical minimum-cross-section formula for circular target supports. Structural considerations in the use of Styrofoam as target-support material are discussed. Methods for achieving low-cross-section bonds between pieces of Styrofoam are also discussed. Author

**N65-13023#** Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati
**PROPOSAL FOR A NEW SYSTEM OF WAVEGUIDE TRANSMISSIONS FOR A RING SUPERCONDUCTOR [PROPOSTA DI UN NUOVO SISTEMA PER INDURRE CORRENTI PERSISTENTI IN UN ANELLO SUPERCONDUTTORE]**
C. Guaraldo, G. Sacerdoti, and A. Susanna 10 Oct. 1964 8 p refs In ITALIAN Submitted for Publication *Its* Nota Interna No. 261
(LNF-64/50)

A new method for inducing continuous currents in a ring superconductor is given. The continuous currents are induced by a circular polarized electromagnetic wave that is transmitted in a circular section waveguide. Trans. by P.F.E.

**N65-13046** Avco Corp., Cincinnati, Ohio. Electronics Div.
**THE DESIGN, DEVELOPMENT AND EVALUATION OF IMPROVED STC EQUIPMENT FOR APPLICATION TO ATC RADARS Final Report**
G. David Hubbard and Ronald J. Wagner Bedford, Mass., AFSC, Electron. Systems Div., Jun. 1964 94 p refs
(Contract AF 19(604)-8854)
(ESD-TDR-64-518; AD-608492)

The need for improved sensitivity time control (STC) circuits in air traffic control radar equipment is stressed and the development of a sophisticated logarithmic STC circuit for the latest EMS search radar is outlined. The development of digital video data processing equipment led to design and experimental work on a digital STC concept. The preliminary investigation of this concept indicates that a significant advance in this direction is possible in clutter-attenuating devices. Reference is also made to the current EMS system, including test results and recommendations for improvements in anti-clutter devices for present and future search and precision radars. Author

**N65-13048#** Michigan U., Ann Arbor. Radiation Lab.
**STUDY AND INVESTIGATION OF A UHF-VHF ANTENNA Bimonthly Report, 1 Jul.–31 Aug. 1964**
J. E. Herman, S. B. Rhee, G. G. Rassweiler, and A. I. Simany Sep. 1964 30 p refs *Its* Rept.-5549-11-P
(Contract AF 33(657)-10607)
(BMR-10; AD-606794)

The experimental ferrite loading of log conical antennas in a recessed cavity and a free-standing log conical and helical antenna reduced the size of the loaded antenna by at least one-half. The corresponding efficiencies of the ferrite-loaded antennas were approximately 25% of the unloaded antenna efficiencies. Temperature measurements of permeability show greatly increased losses above 200° C. A preliminary study of a helix with ferrite loading is described. Author

**N65-13052#** Sperry Rand Corp., Gainesville, Fla. Sperry Electronic Tube Div.
**SHAPED FIELD HOLLOW BEAM ELECTRON GUNS FOR INTERMEDIATE AND HIGH POWER TRAVELING WAVE TUBES Interim Engineering Report No. 2, 1 Aug.–1 Nov. 1964**

Wright-Patterson AFB, Ohio, AF Avionics Lab., Nov. 1964 32 p refs
(Contract AF 33(615)-1501)
(NJ-2761-0173-2; AD-451443)

Experiments with the multisegment electron gun are described. Both positive- and zero-flux linkage cases were studied over a wide range of the parameter $B/\sqrt{V}$. (B is the magnetic field used in the uniform part of the field, and V is the applied beam voltage.) Positive-flux linkage produces a more sharply defined beam than zero-flux linkage. The magnetic fields required to satisfactorily form the beams produced so far are larger than the objective values. No attempts have been made to vary the relative potentials of the anode segments. The inner diameters of the anode segments must be increased before this can be done. Author

**N65-13053#** Innsbruck U. (Austria).
**MAGNETIC DIPOLE ANTENNAS FOR RECEIVERS Scientific Report No. 10**
Wolfram Bitterlich 15 Sep. 1964 17 p refs
(Contract AF 61(052)-490)
(AFCRL-64-928; AD-608969)

Antenna types of small dimensions for the reception of vlf signals < 20 kc/sec are discussed. Dimensioning and design of an optimum ferrite antenna for the vlf region are discussed as well as possible screening. Author

**N65-13074#** Stanford U., Calif. Microwave Lab.
**MICROWAVE RESEARCH Quarterly Status Report No. 22, 1 May–31 Jul. 1964**
Oct. 1964 25 p refs
(Contract Nonr-225(48))
(ML-1235; AD-608506)

Work is reported in the following areas: the microwave region of acoustic wave amplification in piezoelectric semiconductors; the monochromaticity, high power, and directionality of optical masers; the diffraction of light waves by 800 Mc/sec hypersound in single crystals of ADP, $SrTiO_3$, and CdS; controlling the transient buildup of laser oscillations in optical masers; thermomagnetic effects in the quantum region; phonon drag in n-type InSb; the interaction of spin waves and electrons; the design of an ultrasonic microscope; and the focusing of acoustic beams in piezoelectrics. D.E.W.

**N65-13075#** Technical Research Group, Inc., East Boston, Mass.
**WIDE-ANGLE PROPERTIES OF DUAL-REFLECTOR ANTENNAS—EXPERIMENTAL Final Report**
Alan J. Simmons and Thomas C. Cahill Griffiss AFB, N.Y., RADC, Sep. 1964 26 p ref
(Contract AF 30(602)-3170)
(RADC-TDR-64-286; AD-608363)

Two dual-reflector Cassegrain microwave systems were studied experimentally and theoretically for wide-angle performance at 9000 Mc. The parabolic-reflector diameter was 72 in., and the hyperbolic subdish diameter was 14.4 in. in Case 1 (d/D = 0.2) and 21.6 in. in Case 2 (d/D = 0.3). In case 1, a scan of 4 beamwidths off-axis was achieved with 3 dB drop in gain; in Case 2, 5 beamwidths were achieved. Sidelobe level on-axis for Case 1 was about 18 dB; for Case 2 it was about 14 dB. Scanning performance was in good agreement with theory. Author

**N65-13077#** Army Signal Research and Development Agency and Lab., Fort Monmouth, N.J.
**USAEL INTERNAL DEVELOPMENT OF RADIO RECEIVER AN/PRR-9 AND RADIO TRANSMITTER AN/PRT-4**
M. W. Curtis Sep. 1964 173 p
(ECOM-2482; AD-608422)

Three models of a radio transmitter and receiver to be used to direct the individual rifleman were developed and tested. The first of the models included the basic package and the major electrical chasacteristics; the two later models incorporated recommended case modifications to reduce the weight and also electrical modifications for full performance requirements. Satisfactory test results for range, size, weight, reliability, etc. demonstrate the feasibility of the military specifications established for the squad radio. G.G.

**N65-13088#** Michigan U., Ann Arbor. Electron Physics Lab.
**VELOCITY TAPERING AND COLLECTOR POTENTIAL DEPRESSION IN BACKWARD-WAVE OSCILLATORS Final Report, Mar. 5, 1963–Aug. 31, 1964**
J. E. Adair and G. I. Haddad Aug. 1964 66 p refs
(Contract DA-49-186-AMC-68(X))
(Rept.-05670-2-F; AD-449879)

The effects of a circuit phase-velocity taper, a depressed collector, and a prebunched beam on the efficiency of an O-type backward-wave oscillator were examined, and the experimental results are presented in this report. The design of the various parts of the oscillator is discussed. The effects of a sinusoidal beam potential variation on the efficiency of a backward-wave oscillator are presented. Author

**N65-13091#** Weapons Research Establishment (Australia).
**MULTI-STATION SOLUTION OF POSITION FROM DIRECTION FINDING INSTRUMENTS AND RADARS AND THE ANALYSIS OF THE INSTRUMENTAL ERRORS**
H. H. Evans and R. H. Evans Feb. 1963 34 p refs
(WRE-TN-SAD-109) (Declassified)

Methods suitable for a least-squares solution of position from an over-sufficient set of direction finding instruments and radars are described. The residuals are analyzed to give estimates of bias and random errors for ballistic cameras and radars in use at Woomera. Author

**N65-13110#** Harvard U., Cambridge, Mass. Cruft Lab.
**A UNIFICATION OF ANTENNA THEORY AND WAVE THEORY: INFINITE YAGI-UDA ARRAYS**
Robert J. Mailloux 22 Jun. 1964 86 p refs
(Contract Nonr-1866(32); NSF GP-851)
(TR-451; AD-606988) OTS: $4.00

An integral equation for the propagation constant along an infinitely long Yagi structure is derived by expanding the vector potential function in terms of the spatial harmonic solutions of wave theory. This wave-theory formulation is shown to be identical with array theory and is then used to discuss allowed wave solutions, pass and stop bands, and the physical characteristics required of dipoles in order that they support a wave solution. Numerical results of the fundamental integral equation are found to agree quite well with previously published data. Also, two parallel nonstaggered Yagi arrays are considered, and it is shown that the propagation constant of the composite structure either decreases or increases over that of the isolated array depending on whether the symmetric or the antisymmetric mode is excited. The problem of two collinear Yagi arrays is considered, where conditions are given under which a current distribution that is symmetrical about the center of each dipole may be assumed. M.P.G.

**N65-13118#** Weapons Research Establishment (Australia).
**INSTRUMENTATION TRIAL D 584/1, ANALYSIS OF INSTRUMENT PERFORMANCE**
R. H. Evans and A. E. Jordan Jun. 1964 51 p
(WRE-SAD-37)

The FPS16 radar results contain significant bias errors of as yet unexplained origin, but random errors are within specification. The performances of the doppler and Contraves systems were generally satisfactory. The ballistic cameras employed to photograph a flashing light produced satisfactory records, but the experimental use of a sequenced shutter control to track a continuous light was not successful for other ballistic cameras. Author

**N65-13138*#** Kollsman Instrument Corp., Elmhurst, N.Y.
**STUDY OF LASER POINTING PROBLEMS Bi-Monthly Technical Report, 3 Aug.–30 Sep. 1964**
Aaron Wallace 15 Oct. 1964 113 p refs
(Contract NASw-929)
(NASA-CR-59874; KIC-RD-000162-1) OTS Prices: HC $4.00/MF $0.75

The laser-beam-pointing problem associated with the potential use of lasers in communications between a vehicle in deep space and an earth station is being investigated. The advantages of laser communication are based on low-power transmitters in deep space vehicles, extremely narrow bandwidths (0.01 to 1.0 arc seconds) and very wide band frequency channels that offer high information rate real-time data transmission. An analysis of the factors and variables involved in the total vehicle–ground station–environment complex shows that the presence of the earth's atmosphere in the communications link introduces additional requirements for system synthesis beyond extraordinary optical precision, due to the narrow beamwidths and the dynamics of closed loop operation with transit time effects and target-observer motions. Other progress reported includes the establishment of reference axes, investigation of techniques for measuring and positioning the laser beam, and analysis of fine beam steering and boresight maintenance. M.P.G.

**N65-13153#** Raytheon Co., Bedford, Mass. Space and Information Systems Div.
**INVESTIGATION OF ACTIVE DOPPLER VELOCITY SENSOR Quarterly Engineering Report No. 3, 1 Dec. 1962–28 Feb. 1963**
Mar. 1963 95 p refs
(Contract AF 33(657)-9241)
(BR-2311; AD-299273)

Results are presented of the advancement of the state-of-art of doppler navigation radar techniques to meet the high-speed, high-altitude requirements of an aerospace vehicle. The development, fabrication, and laboratory testing of a linear microwave FM generator with good short-term stability was essentially completed. The automatic slope control program was enlarged to include the general subject of velocity computation by two methods: (1) modulation slope dependent; and (2) modulation slope independent. Development of a flyable unit to evaluate these two techniques continues. Analytical predictions of the accuracy of these two spectral compression systems and a CW system were made. Author

**N65-13171#** Radiation, Inc., Melbourne, Fla. Antenna and Microwave Engineering Section
**STUDY OF SPECIAL BEAMSHAPING ANTENNAS Final Report, 1 Jul. 1963–30 Jul. 1964**
R. E. Moseley, B. L. Lewis, L. Pietsch, H. E. Bartlett, and G. W. Collins [1964] 254 p refs
(Contract DA-36-039-AMC-03310(E))
(Rept.-4; AD-607321)

This report describes the theoretical and experimental investigations conducted during a program to investigate the applicability of end-fire, dielectric radiating elements in easily transportable satellite communications antenna arrays. Investigations of the applicability of these elements as primary feeds for lenses and reflectors are also described. This program has provided a new and workable theory that is applicable to a wide range of element sizes and materials. The theory has resulted in the development of the Foamrod antenna, which has an order of magnitude greater gain than conventional end-fire dielectric elements. An array design plan was written that described an array equivalent to a 30-ft-diam parabolic antenna, which could be constructed using only 64 elements, and which had transportability advantages over the parabolic antenna. For a feasibility model, a 16-element array was designed for electrical performance equivalent to a 15-ft diam-paraboloid operating simultaneously at 1.8 Gc and in the 7.2 to 8.4 Gc band. The results of measurements on this model are presented. Author

**N65-13188#** Naval Missile Center, Point Mugu, Calif. Systems Evaluation Office
**TABLES AND CURVES FOR RADAR RANGE CALCULATIONS**
L. L. Rogers 2 Sep. 1964 16 p
(NMC-MP-64-7; AD-447432)

Radar range performances were studied and related to given targets. The continuous calculations of the target cross-sectional areas and the calculations of the radar power changes versus the detection range were made. The calculated and normalized data are presented in tabular graphical form. G.G.

**N65-13195#** Oak Ridge National Lab., Tenn. Chemical Technology Div.
**OFF-GASES FROM THE REACTIONS OF URANIUM CARBIDES WITH NITRIC ACID AT 90° C**
L. M. Ferris and M. J. Bradley Dec. 1964 22 p refs
(Contract W-7405-ENG-26)
(ORNL-3719) OTS: $2.00

The uranium carbides UC, $U_4(C_2)_3$, and $UC_{1.85}$ dissolved in 2 to 16 M $HNO_3$ in 10 hr or less at 90° C, yielding off-gases comprised mainly of $NO_2$, NO, and $CO_2$. The off-gas compositions varied with the acid concentration: in dilute (2 to 4 M) acid, NO was the main nitrogen oxide present, whereas $NO_2$ predominated at higher acid concentrations. Traces of $N_2O$ were found, but no CO, $H_2$, or gaseous hydrocarbons were detected. The carbides were almost completely passive in very dilute (0.001 to 0.5 M) acid. Between 30% and 50% of the carbide carbon was converted to species soluble in nitric acid irrespective of the carbide, reaction time, or variation of acid concentration between 2 and 16 M. Author

**N65-13200#** Naval Ordnance Lab., Corona, Calif. Electronics Div.
**AN EXPERIMENTAL VLF DIPOLE TRAVERSING AN ISLAND**
E. W. Seeley, P. E. Tallant, and I. Rainwater *In its* Foundational Res. Proj. 1 Sep. 1964 p 17–37 refs (See N65-13198 03-06)

The results of an experimental investigation of a horizontal dipole antenna traversing San Nicolas Island are reported. The antenna consisted of insulated wires lying on the ground and, in later studies, elevated above it. Several characteristics of the antenna were measured including effective height, current distribution, efficiency, input impedance, bandwidth, radiated power, and radiated electric field at a receiving site 252 km away. Ground conductivity of the island was also measured. As a result of the investigation, it was concluded that

the wire across the island did not cause the island to radiate like a slot antenna. The impedance measurements did not reveal unusual resonances corresponding to the length of the island, and the signal at the receiving site was about the intensity theoretically predicted for a horizontal dipole. D.E.W.

**N65-13233#** Syracuse U. Research Inst., N.Y. Defense Systems Lab.
**SIGNIFICANCE OF TARGET CHARACTERISTICS UPON PRECISION OF MONOPULSE RADAR**
John M. Caster and Arthur A. Walier, Jr. Jun. 1964 68 p
(Contract DA-36-039-AMC-00033(E))
(DSL-R-94; AD-451663)

Monopulse is a state-of-the-art arrived at after recognizing and overcoming the limitations of prior states. Extended targets cause perturbations to the uniform plane wave generally associated with the classical antenna pattern. These perturbations are the limitation to the applicability of monopulse. That a monopulse system indicates the direction of arrival of a wave front is true only in the case of a simple target, is approximately true for a complex target, but is not generally true for a compound target. In applying monopulse techniques to a radar system, the engineer is often confronted with optimizing accuracy while minimizing sidelobe response. The relationship between these objectives and, therefore, the tradeoff available is pointed out. Regardless of the information that exists in the antenna channels, the degree of success of a particular system depends upon the processing circuits. Author

**N65-13246#** New Mexico State U., University Park. Physical Science Lab.
**CIRCULARLY POLARIZED DUAL FREQUENCY FAN BEAM ARRAY AND HEMISPHERICAL COVERAGE ANTENNAS FOR SATELLITE TRACKING Final Report, 30 Nov. 1961–20 Aug. 1964**
J. H. Diel 20 Aug. 1964 87 p refs
(Contract NOrd-16710)
(CR-14; AD-607988)

This report describes the work accomplished in connection with the design of two types of satellite-tracking antennas, a fixed antenna with hemispherical coverage and left circular polarization, and a preset fan beam array with left circular polarization. The work included a study of some of the various parameters affecting the shape of the pattern of a turnstile above a ground plane, the polarization of a turnstile above a ground plane and the impedance of a turnstile antenna. In addition, three prototype antennas were designed and built, two single-frequency fixed antennas, and one dual-frequency preset fan beam array. The appendix describes the method used to establish the location of the electrical phase center.
Author

**N65-13250#** Naval Research Lab., Washington, D.C.
**A FIXED-ARRAY, HIGH-DATA-RATE, SEARCH AND HEIGHT-FINDING RADAR. PART 2: BEAM-STEERING COMPONENTS**
W. H. Harper 8 Sep. 1964 34 p refs
(Rept.-6142; AD-449628)

Beam-steering components were developed for the transmit and receive systems of an experimental electronically steered radar. Beam-forming networks, microwave beam-selector switches, and the rf portion of a transmit phase control loop are discussed. Phasing signals for 16 beam positions are formed by a transmit phase generator that has been constructed in the form of a dual beam-forming matrix. A low-loss, broadband, programable microwave switch using varactor diodes selects the correct input port of the dual matrix. The output arms of a quadrature hybrid are terminated in a resistance-detector combination in such a manner that phase errors at the end of an amplifier chain are represented by amplitude differences at the outputs of this phase comparator. A compound matrix composed of multiple beam-forming matrices, capable of generating simultaneous elevation and azimuth beams for the receive system was constructed. Author

**N65-13281*#** Michigan U., Ann Arbor. Radiation Lab.
**ON THE ANTENNA RADIATION THROUGH A PLASMA SHEATH**
A. Olte and Y. Hayashi Jun. 1964 106 p refs *Its* Rept.-5825-1-F
(Grant NsG-472)
(NASA-CR-59905) OTS Prices: HC $4.00/MF $0.75

The influence of the plasma sheath on the slot-antenna properties is considered. It is shown that opening a slot in a thin overdense plasma sheath reestablishes in many cases the radiation of an elementary cylinder antenna. The changes in the impedance of a cavity-backed slot antenna with the onset of a plasma sheath are formulated on the basis of an energy theorem. Author

**N65-13283*#** Santa Barbara Research Center, Goleta, Calif.
**INVESTIGATION OF F-1 MRIR Final Report**
F. R. Malinowski 2 Nov. 1964 70 p
(Contract NAS5-757)
(NASA-CR-60034) OTS Prices: HC $3.00/MF $0.75

The erratic behavior of the F-1 MRIR radiometer micron channels was investigated and the extent of the calibration change from the original calibration was determined. The changes in calibration were traced to a transmission decrease of the optical filters (probably due to UV radiation sustained during test flights) and to condensation water collection on one of the filters. The decrease of torque output in the scan mirror assembly was found to be the result of faulty wiring. The original calibration data and the data points obtained during the calibration checks are listed in an appendix. G.G.

**N65-13291#** Michigan U., Ann Arbor. Electron Physics Lab.
**RESEARCH AND DEVELOPMENT OF HIGH-POWER CRESTATRONS FOR THE 100–300 MC FREQUENCY RANGE Quarterly Progress Report No. 17, Jul. 1–Oct. 1, 1964**
G. T. Konrad and C. K. Rhee Oct. 1964 25 p
(Contract NObsr-81403)
(Rept.-03783-18-P; AD-451424)

The data obtained in a beam analyzer on a $P_\mu = 20$ hollow-beam electron gun are presented. Certain defects in the gun as well as the beam analyzer require that these data be redone. The final model of the 100-W Crestatrons to be constructed is described. Performance data and the required environmental tests were obtained, and are summarized in this report. On the basis of these results construction of the three final tubes appears to be warranted. Author

**N65-13300*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**OPTIMUM AND SUBOPTIMUM FREQUENCY DEMODULATION**
William C. Lindsey 15 Jun. 1964 29 p refs
(Contract NAS7-100)
(NASA-CR-59915; JPL-TR-32-637) OTS Prices: HC $2.00/MF $0.50

The design and mechanization of frequency demodulators for use in telemetry communications are discussed. The frequency demodulator consists of an ordinary phase-locked loop

(PLL) followed by a linear-output filter. The linear and quasi-linear PLL demodulator models are optimized by choosing the loop filter transfer function that minimizes the mean-squared phase error, whereas the output filter transfer function is optimized by selecting the linear filter that minimizes the mean-squared frequency error. These filters are adaptive in that their pole zero configuration depends on the available signal power, the noise spectral density, and the modulation index. Because the filters are difficult to mechanize, two alternate and more easily implemented suboptimum frequency demodulators are analyzed. These are obtained by selecting the loop and output filters that are optimum for a certain set of design levels and by preceding the loop either by a bandpass limiter or an automatic gain control (AGC) amplifier. Synthesis procedures for the optimum-loop and output filters are given, and the transient behavior of the optimized system is determined. A major conclusion is that the PLL that is preceded by an AGC amplifier outperforms the same loop when it is preceded by a bandpass limiter. Author

**N65-13317#** Naval Research Lab., Washington, D.C. Tracking Branch
**POLARIZATION TECHNIQUES AND COMPONENTS FOR RADAR AND COMMUNICATION SYSTEMS Interim Report**
P. J. Allen and R. D. Tompkins 30 Jul. 1964 12 p refs Presented at the 1963 Northeast Electron. Res. and Engineering Meeting, Boston, Nov. 1963
(NRL-6099; AD-606951)

Antenna axial ratio and sense are determined by the relative amplitudes of the two oppositely sensed CP components, whereas wave orientation is determined by their relative phase. Such polarization control might also be used either to optimize antenna response to a desired signal, or to minimize response to an undesired signal of different polarization. When necessary, the polarization of an incident wave can be determined or displayed using an instantaneous polarimeter or a component resolver. Applications of polarization techniques have been developed into a powerful method of evaluating axial ratio characteristics of antennas. A novel continuous phase shifter has been developed that illustrates the use of circular polarization to achieve efficient frequency translation; X-band components are used as examples. Author

**N65-13319#** Illinois U., Urbana. Radiolocation Research Lab.
**PATTERN-BANDWIDTH OPTIMIZATION OF THE SLEEVE MONOPOLE Technical Report No. 6**
A. J. Poggio Oct. 1964 51 p refs
(Contract NObsr-89229)
(RRL-258; AD-607320) OTS: $3.00

The effect of varying the physical dimensions of the sleeve monopole upon its electrical characteristics is predicted theoretically by analogies with uniform radius cylindrical antennas and is verified experimentally. The theory of matching networks is sufficiently developed, and it is shown that an impedance matching system can be located within the sleeve structure. It is also shown that the radiation pattern can be optimized over a given band and then, by using matching networks, the VSWR can be maintained below a certain level without altering the pattern. It is made evident that, subject to the Fano criteria, the impedance bandwidth can be optimized independently of the radiation pattern. A system is designed to satisfy typical specifications, and the techniques used are clearly illustrated. Author

**N65-13336#** Harvard U., Cambridge, Mass. Cruft Lab.
**JOINT OPTIMIZATION OF TRANSMITTER AND RECEIVER IN PULSE AMPLITUDE MODULATION**
Donald W. Tufts and David A. Shnidman 14 Jul. 1964 18 p refs
(Contract Nonr-1866(16))
(TR-444; AD-607094) OTS: $2.00

Jointly optimum transmitted waveforms and linear time-varying receivers are specified for pulse-amplitude-modulation systems that are subject to two kinds of interference, noise and intersymbol interference. The mean-square error in the receiver's reproduction of the random message sequence is used as the performance criterion. The joint optimization is carried out in detail for the case of signaling through a noisy RC filter. Special emphasis is placed on the empirical exploration of performance variations caused by different choices of the message correlation matrix. Author

**N65-13338#** General Electric Co., Pittsfield, Mass. Ordnance Dept.
**DESIGN STUDY OF A TRANSPORTABLE ANTENNA SYSTEM, VOLUME I Final Report**
P. A. Blasangame, W. H. Rote, C. C. Wales et al Nov. 1963 158 p refs
(Contract DA-36-039-SC-90713)
(AD-423403) OTS: $11.00

Since error dominates the system design, a detailed discussion of error and error analysis is presented. The discussion is divided into the following areas: (1) a broad examination of all possible axis configurations for a satellite tracker design; (2) resolution of total tracker error into components in a logical manner and definition of terms; (3) mathematical classification of errors; (4) classification of errors on a geometric basis; (5) division of tracking errors into categories—beacon induced, propagation, receiving circuitry, electrical noise, linear, nonlinear, and noise errors; (6) error in angle determinations due to misalinment of the tracker axis; and (7) encapsulation of the presented material on error into a summary that may be used as the basis for error analysis. P.V.E.

**N65-13344#** Harvard U., Cambridge, Mass. Cruft Lab.
**INTERACTION OF SIGNAL AND NOISE IN A NONLINEAR SYSTEM**
P. Trafton and D.W. Tufts 27 Jul. 1964 53 p refs
(Contract Nonr-1866(16))
(TR-450; AD-607255) OTS: $3.00

An experimental system has been constructed that simulates the detection stage of a receiver. With the application of periodic bursts of sine-wave plus gaussian noise at the input, the output of this system is a nonstationary random process. The addition of noise to the signal suppresses the mean at the output for the half-wave linear detector. However, the mean is unchanged for the half-wave square-law detector. The nonstationary variance is seen to vary between two values that can be easily measured. Output signal-to-noise ratio is greater for the half-wave square-law device than for the half-wave linear device. Addition of a clipper to the half-wave linear device decreases the signal-to-noise ratio. Detection characteristics of the half-wave linear and half-wave square-law devices are found to be equivalent, and the clipper degrades the detection characteristic. Author

# 08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

**N65-12377#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**MATHEMATICAL BASES OF A DIGITAL DIFFERENTIAL ANALYZER**
Ye. P. Zhidkov *In its* Autom. Control and Computer Tech. 25 Aug. 1964 p 257–271 refs (See N65-12367 03-34)

The coupling between the integrators and servointegrators in a digital differential analyzer, to solve various problems of ordinary differential equations, is discussed for the following mathematical operations: (1) representation, addition, and subtraction of the contents of the R-register and Y-register of the discrete integrator, and selection of the scales of the variable; and (2) use of the servointegrator as an adder to obtain the product or quotient of two variables u and v—varying the scales of the variable, multiplication of a variable by a constant to obtain the function arc sin x, and transfer of control by means of a servointegrator. Setup diagrams and examples of their use for each of these mathematical operations are given. M.P.G.

**N65-12378#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**DIGITAL INTEGRATING MACHINES**
F. V. Mayorov *In its* Autom. Control and Computer Tech. 25 Aug. 1964 p 272–346 refs (See N65-12367 03-34)

Digital integrating machines are described as having the advantages of both analog and digital machines. After tracing the development of such machines, primarily in the U.S., the basic block diagram is presented and the following are discussed: the principle of integration, the system of encoding numbers, the integration operation, the magnetic-drum serial integrator, connection of integrators, input of initial conditions and switching-on of machines, operation of the servointegrator, scale factors, special cases of the formation of functions, input of functions using perforated tapes, input of functions in the form of graphs, and graphic recording of the result of calculations. M.P.G.

**N65-12438*#** Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
**STUDIES OF MANUAL CONTROL SYSTEMS Progress Report No. 4, 19 Apr.–18 Jul. 1964**
1 Oct. 1964 32 p refs
(Contract NASw-668)
(NASA-CR-59720) OTS Prices: HC $2.00/MF $0.50

Described and discussed is a digital-computer system, Signal Analyzer I, for analyzing the signals and identifying the dynamic characteristics of the elements of manual-control systems. The main purpose of Signal Analyzer I is to determine the describing functions of the human operator and of other control-system elements according to the multiple linear-regression-analysis paradigm developed by Elkind *et al.* The Signal Analyzer I system is written in Decal–BBN programing language, which incorporates a number of ALGOL-like facilities and a powerful algebraic compiler that allows subscripted variables and array handling as well as a fairly complete set of floating-point subroutines. P.V.E.

**N65-12448#** Weather Bureau, Washington, D.C. Meteorological Satellite Lab.
**METEOROLOGICAL PRODUCTS FROM DIGITIZED SATELLITE VIDICON CLOUD PICTURES**
C. L. Bristor and W. M. Callicott Jan. 1964 41 p refs
(MSL-26)

Procedures are described whereby digitized vidicon cloud photos will be computer processed. Data rates, preprocessing, rectification, and mapping are discussed, and problem areas are indicated. The kinds of output are described, and products from various display devices are provided through checkout samples. Author

**N65-12508*#** Sperry Rand Corp., Blue Bell, Pa. UNIVAC Div.
**RELIABLE LOW-POWER THIN-FILM SPACECRAFT MEMORY Final Report**
G. Fedde et al [1964] 243 p
(Contract NAS5-3171)
(NASA-CR-60025) OTS Prices: HC $6.00/MF $0.50

This paper describes a reliable, low-power, thin-film spacecraft memory that operates successfully over a temperature range from −20° to +50°C. Plated wires are used for storage elements containing 98 304 bits, which can be accessed bit serially at any bit rate up to 100 000 bits per second. The circuitry is packaged in cordwood modules. It was demonstrated that the memory operated reliably at a bit rate in excess of the specified 100-kilocycle bits per second. Information errors occurred when the interval between the clock pulses was 8 microseconds. G.G.

**N65-12570#** Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
**MULTICHANNEL REAL-TIME TELEMETRY DATA REDUCTION SYSTEM**
John K. Baird and Jacky D. Cates Dec. 1963 22 p
(ERDA-96; AD-429534)

The real-time telemetry system (RTS) increases the capability of White Sands Missile Range telemetry data-processing facilities by performing automatic linearization and scale factoring in real-time. A preflight calibrator, designed for use with the system, connects to the missile telemetry system and automatically calibrates the telemetry-data transmission link from the transducer output to tht RTS output. The system has the capability to reduce eight channels of telemetry data and provides both analog and digital output. Author

**N65-12594#** International Business Machines Corp., Yorktown Heights, N.Y. Thomas J. Watson Research Center
**COMPUTER STORAGE INTEGRATION GROUP AN/GYA-() Final Report**
Griffiss AFB, N.Y., RADC, Oct. 1964 154 p
(Contract AF 30(602)-2754)
(RADC-TDR-64-214; AD-451972)

The object of this program was to provide a hardware system capable of testing the feasibility of certain concepts. The implementation was done in two phases. The first phase included assembly of all hardware components, but restricted operations to the absolute mode of addressing in which the storage group provided little more than rapid access, high density storage capabilities. The second phase included the content addressable mode, which provides a relatively powerful approach to problems of nonnumerical processing in general and, specifically, to information retrieval and translation. The equipment functions necessary to perform these software programs are fully described. Author

**N65-12603*#** National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
**AOPB SYSTEMS MANUAL PROGRAM DESCRIPTION: MYSTIC TRACER**

Patricia Ann Brown Savage Sep. 1964 39 p
(NASA-TM-X-55116; X-542-64-262) OTS Prices: HC $2.00/MF $0.50

A Mystic tracer program is described that utilizes the IBM-1401 bumper program to prepare the program and subroutines to be traced. The tracer is set up as a subroutine at a point in the sequence of commands at which the user desires tracing to began; then the program to be traced is compiled with the function command to call the tracer already inserted. The Mystic tracer then takes over and continues until the Begin command calling the tracer is reached, at which instant the control is returned to the main program, and the execution continues. G.G.

**N65-12666#** Joint Publications Research Service, Washington, D.C.
**ELECTRONIC CONTROL COMPUTERS**
15 Dec. 1964 34 p Transl. into ENGLISH from Electrotekh. (Moscow), no. 7, Jul. 1964 p 1–10
(JPRS-27848; TT-64-51942) OTS: $2.00

A paper on the automation of production control by means of electronic computer engineering considers the structure and functioning of automatic control systems, plant information structure, savings of the system, and requirements for the introduction of automatic production-control systems. A second paper considers a universal solid-state digital control computer and system of automatic data processing, called VNIEEM-1. The computer may be used for control of different industrial processes, for automatic data processing, and for numerical analysis. An overall description of the computer is given, and the individual functional units, such as printout, ferrite-core memory unit, adder, etc., are discussed. Operations, information format, representations of information, and other aspects of machine function are given, and a table displays the specifications of the computer. D.E.W.

**N65-12740#** California U., Livermore. Lawrence Radiation Lab.
**AN IRREGULAR TRIANGLE MESH GENERATOR**
Alan M. Winslow 25 Aug. 1964 42 p refs
(Contract W-7405-ENG-48)
(UCRL-7880) OTS: $2.00

A code is described that constructs an irregular-triangle mesh. Input to the code is prepared by dividing the mesh into regions of uniform material properties and by specifying the coordinates of selected points on the boundary of each region. The code then interpolates the omitted boundary points, locates the internal mesh points of each region by the pseudoequipotential method, and assigns regional properties to each triangle. Except that a region boundary may not cross itself, there are no restrictions on the shape of a region. The iterative procedure that relaxes the mesh uses an overconvergence factor, which is recalculated each cycle and maintained close to the optimum value to minimize the number of cycles needed for convergence. Author

**N65-12751#** General Motors Corp., Santa Barbara, Calif. GM Defense Research Labs.
**A UNIFIED MATRIX APPROACH FOR THE COMPUTATION OF REAL GAS FLOWS**
M. D. Farmer and A. Q. Eschenroeder Aug. 1964 204 p refs
(Contract DA-04-495-ORD-3567(Z); ARPA Order 357-63; Proj. Defender)
(TR64-02E; AD-449861)

A method was developed for the solution of chemically reacting flow problems. It was implemented in the form of a code for high-speed digital computation. Although thermochemical equilibrium is assumed, the chemical model allows the arbitrary specification of up to 10 elements, which may form up to 40 compounds (or radicals). The unified technique is built around a master matrix that leads to the solution of several different problems. The problems fall into the broad categories of static state, shock flow, and isentropic flow. Caloric behavior of species may be arbitrarily specified by means of fifth-order polynomial curve-fit coefficients. The development is presented in the successive stages of analysis, program listings, and flow diagrams. Author

**N65-12765#** Atomics International, Canoga Park, Calif.
**A TRANSIENT MULTICHANNEL TWO-PHASE HYDRAULIC CODE**
L. R. Steele and R. F. Berland 1 Dec. 1964 68 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-9425) OTS: $1.50

A description of a computer program that calculates both steady-state and transient distribution of flow in a reactor core is presented. Results are compared to experimental data for the transient characteristics and to another program for the steady-state distribution of flow. The program may handle a single channel or multiple channels with crossflow under either natural or forced circulation. Author

**N65-12828#** Iowa State U. of Science and Tech., Ames. Ames Lab.
**ORIGIN IMAGE SEEKER, AN IMAGE SEEKING PROGRAM FOR PATTERSON PROJECTIONS AND HARKER SECTIONS**
D. A. Hansen and D. H. Erbeck Jul. 1964 26 p
(Contract W-7405-ENG-82)
(IS-965) OTS: $0.50

Origin Image Seeker is a program for the IBM-7074. It is written in FORTRAN, although the program uses an Autocoder subroutine. This program determines trial structures from Patterson projections and Harker sections provided that the projection contains either a real or projected atom at the origin, or that the section contains a real atom at the origin. Author

**N65-12861#** European Atomic Energy Community, Brussels (Belgium).
**THE SIOUX SYSTEM**
A. van Wauwe Sep. 1964 35 p refs
(EUR-1917.e) Available from Belgian Am. Bank and Trust Co., N.Y., Account No. 22.186: 50 Belg. Fr.

This report describes a hybrid extension for the PACE 231R analog computer, called SIOUX-system (Sequential and Iterative Operation Unit X groups). The basic idea of the system is that the states of the analog computing elements (in particular the modes Initial Condition, Operate, and Hold) are controlled by digital instructions, the elementary operations being analog runs. Author

**N65-12919#** Brown Engineering Co., Inc., Huntsville, Ala. Research Labs.
**A FORTRAN PROGRAM FOR CALCULATING THREE-DIMENSIONAL BALLISTIC TRAJECTORIES**
C. F. Ostner and H. S. Dupree, Jr. 1 Oct. 1964 50 p
(R-115; AD-608358)

This program computes a ballistic trajectory from launch or any point thereafter to any other time or to impact. Point masses and a rotating oblate spheroid earth are assumed. The program is written in FORTRAN IV and is used on the IBM-7040 computer. It will accommodate a one-, two-, or three-stage vehicle. Author

**N65-12962#** Polacoat, Inc., Blue Ash, Ohio.
**SYNTHESIS OF INORGANIC PHOTOTROPIC MATERIALS FOR HIGH DENSITY COMPUTER MEMORY APPLICATIONS**
R. Radler and C. Chenot Wright-Patterson AFB, Ohio, AF Avionics Lab., Oct. 1964 82 p refs
(Contract AF 33(657)-11510)
(AL-TDR-64-170; AD-608426)

This report is a detailed description of the research performed to develop a transparent, tenebrescent glass filter that would have potential as an optical memory for digital computers. A technique is described by which a nearly transparent hackmanite-type glass was prepared. The technique makes use of the precipitation of a tenebrescent phase from a glass matrix. Infrared absorption curves, analytical results, and the effects of compositional variations are discussed. The development of a rare-earth-doped potassium glass is also described, along with its optical properties and compositional variations. Author

**N65-12982#** New York U., N.Y. Courant Inst. of Mathematical Sciences
**SOME EXPERIMENTS IN ALGEBRAIC MANIPULATION BY COMPUTER**
Arnold Lapidus and Max Goldstein 1 Oct. 1964 34 p refs
(Contract AT(30-1)-1480)
(NYO-1480-11)

A set of subroutines to allow algebraic manipulations on the IBM-7094 Computer was written by using a List Processor, SLIP. A series of four problems of increasing difficulty were solved by using these routines. These problems were as follows: (1) to expand and simplify a polynomial in three variables; (2) to substitute one truncated power series into another; (3) to obtain the series solutions of two ordinary differential equations by equating coefficients; and (4) to obtain a partial expansion of the Fourier series solution to Laplace's equation on a rectangular region with one irregular boundary. Author

**N65-13004#** General Precision, Inc., Glendale, Calif. Research and Systems Center
**ASSOCIATIVE PROCESSOR STUDY**
R. H. Fuller and J. M. Salzer Griffiss AFB, N.Y., RADC, Oct. 1964 113 p refs
(Contract AF 30(602)-3371)
(RADC-TDR-64-437; AD-608427)

This report describes the application of a new concept of machine organization for nonnumerical problems to the problems of pattern recognition and processing using associative techniques. A pattern processor is described that both extracts properties and classifies patterns by means of the preferred techniques. D.E.W.

**N65-13158*#** Stanford U., Calif. School of Medicine
**DENDRAL-64—A SYSTEM FOR COMPUTER CONSTRUCTION, ENUMERATION AND NOTATION OF ORGANIC MOLECULES AS TREE STRUCTURES AND CYCLIC GRAPHS. PART I: NOTATIONAL ALGORITHM FOR TREE STRUCTURES**
Joshua Lederberg 15 Dec. 1964 34 p refs
(Grant NsG-81-60)
(NASA-CR-57029) OTS Prices: HC $2.00/MF $0.50

A preliminary version of a proposed system called Dendral-64, for topological ordering of organic molecules as tree structures is presented. The present system was designed as a computer program to make an exhaustive, nonredundant list of all the structural isomers of a given formula. D.E.W.

**N65-13247#** Joint Publications Research Service, Washington, D.C.
**STUDIES IN COMPUTER DEVELOPMENT**
23 Nov. 1964 71 p refs Transl. into ENGLISH from Avtomatyka (Kiev), v. 9, no. 4, 1964
(JPRS-27483; TT-64-51732)

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**N65-13316*#** Franklin Inst., Philadelphia, Pa.
**A COMPUTER PROGRAM FOR HYDROSTATIC BEARINGS INCLUDING THE EFFECTS OF NON-UNIFORM FILM THICKNESS AND RELATIVE VELOCITY FOR VARIOUS METHODS OF LUBRICANT SUPPLY Final Technical Report**
J. G. Hinkle, V. Castelli, H. C. Rippel, and C. D. Zimmerman, Jr. Apr. 1964 102 p refs
(JPL-BP-3-211570)
(NASA-CR-59916; F-B2099) OTS Prices: HC $4.00/MF $0.75

This report describes the development and use of a computer program for the determination of the load-carrying capacity, flow requirements, and righting moments of hydrostatic bearings using an incompressible fluid, including the effects of variable film thickness, relative velocity, and method of lubricant supply. The basic equations, numerical approximations, method of solution, numerical treatment, and FORTRAN program are presented along with instructions on the use of the program and a sample problem. Author

# 09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

**N65-12355#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**METHOD OF REPRODUCTION OF SMALL VOLTAGES OF HIGH FREQUENCY**
B. Ye. Rabinovich *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 36–45 ref (See N65-12351 03-34)

Described is a method for the reproduction of small voltages occurring at high frequencies. In the method, the voltages generated on a known resistance during passage of a current of the second or higher harmonic are measured. The current is obtained from the plate current of a diode connected to the circuit of the alternating voltage to be measured. P.V.E.

**N65-12356#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**STANDARD METHOD OF REPRODUCTION OF SMALL VOLTAGES OF HIGH FREQUENCY ON SEVERAL HARMONICS**
B. Ye. Rabinovich *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 46–57 (See N65-12351 03-34)

A method for reproducing small voltages occurring at high frequency, taken from a known resistance connected into the circuit of a diode detector, is extended to even higher frequencies. In particular, the investigation is concerned with establishing the cause of the divergence of calculated and experimental values of the reproduced voltage at higher frequencies, and establishing of regularity of systematic error at large currents of the diode. P.V.E.

**N65-12357#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INVESTIGATION OF ERRORS OF STANDARD EQUIPMENT FOR REPRODUCTION OF SMALL VOLTAGES AT FREQUENCIES UP TO 1000 Mc**
G. M. Strizhkov *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 58–70 refs (See N65-12351 03-34)

The errors that occur in most of the standard equipment used in reproducing small voltages at frequencies up to 1000 Mc are considered. The various factors that account for the errors in reproduction are discussed. It is shown that, for frequencies up to 500 Mc, reproduction errors do not exceed ±0.7% and that, for frequencies up to 1000 Mc, the errors do not exceed ±1.8%. P.V.E.

**N65-12359#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INVESTIGATION OF METHOD OF MEASUREMENT OF ATTENUATION WITH HELP OF SHORT-CIRCUITING PISTON**
Ye. I. Strelkova *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 79–95 (See N65-12351 03-34)

Methods for the measurement of attenuation using short-circuiting pistons are considered, and the errors that result are discussed in detail. Results of measurements of various values of attenuation at various frequencies by methods employing square-law detectors and short-circuiting pistons are compared. It is concluded that the short-circuiting piston method is expedient only when used in the measurement of small attenuations. P.V.E.

**N65-12360#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INVESTIGATION OF FREQUENCY ERRORS OF ATTENUATOR ON WIRE RESISTANCES**
B. Ye. Rabinovich and O. V. Stoyakin *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 96–102 refs (See N65-12351 03-34)

Described are the method and results of investigation of an attenuator made of wire resistances and intended for a frequency of 4 Mc. It was shown that the frequency error of a 90-dB attenuator does not exceed three hundredths of a decibel. Author

**N65-12363#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**STANDARD WAVEGUIDE LOADS OF CENTIMETER RANGE**
L. N. Bryanskiy and Ye. B. Zal'tsman *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 120–131 refs (See N65-12351 03-34)

Described are designs and methods of evaluation of standard mobile loads. Investigated are the sources of the errors of VSWR with the help of mobile loads. Estimated is the total error of evaluation of standard waveguide loads with a VSWR approximately equal to 2. Author

**N65-12365#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**SPECTRUM OF GENERATOR OF RADIOPULSES WITH STEEP FRONT**
L. A. Pereverzev *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 137–154 refs (See N65-12351 03-34)

Calculated is the spectrum of a generator of radio pulses with steep fronts, intended for checking radio interference meters. The modulation of the control grid is examined. During modulation of an asymmetric circuit, the undesirable components of the spectrum are of noticeable magnitude. Application of a symmetric circuit decreases this magnitude. On the basis of the relationships obtained the optimum duration of the front is determined with respect to possible errors. Author

**N65-12366#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ERROR OF HARMONIC ANALYSIS OF VOLTAGE, MADE WITH HELP OF MEASURING RECEIVER WITH DIODE MIXER**
M. M. Levin *In its* Invest. in the Field of Radiotech. Meas 15 Sep. 1964 p 155–163 refs (See N65-12351 03-34)

Measuring receivers of superhigh frequencies (SHF) and certain high frequency measuring receivers do not have preselectors. Without a preselector, there is fed into the measuring receiver the voltage of the first harmonic of the measured frequency in addition to the voltage to be measured. This additional voltage introduces an error into the measurement of the original frequency. The error produced as a result of the effect is investigated, and the results of the investigation are presented and discussed. P.V.E.

**N65-12373#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ELECTRO-HYDRAULIC CONTROLLERS**

Yu. Ye. Ruzskiy *In its* Autom. Control and Computer Tech. 25 Aug. 1964 p 151–186 refs (See N65-12367 03-34)

The static and dynamic characteristics of new electrohydraulic control equipment are described, and examples of their use in regulation and control of industrial processes are given. A versatile electrohydraulic control system is diagramed and the theory and operation of its component parts are discussed, including the transducer, the differentiating cell, the amplifier, the electrohydraulic tranducer, the servodrive, and the isodromic feedback. The use of this system with jet amplifiers, for electrical control systems with an automatic electronic compensator, for wind-tunnel control, and for distribution of the load of an electric powerstation is considered. M.P.G.

**N65-12376#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ELECTROMAGNETIC CLUTCHES FOR ACTUATING MECHANISMS**

P. F. Klubnikin *In its* Autom. Control and Computer Tech. 25 Aug. 1964 p 232–256 refs (See N65-12367 03-34)

The use of electromagnetic clutches as servomotors is discussed. Such clutches must have a simple design, high power amplification factor, high output shaft acceleration, reliability, and, preferably, nearly linear characteristics. Types of electromagnetic clutches discussed are friction clutches, including dry friction and semifluid friction or magnetic emulsion types, and slip clutches. In the magnetic emulsion type of clutch, the moment being transmitted by the clutch increases almost linearly with an increase in magnetic flux or current in the winding of the electromagnet, and the moment being transmitted at different currents is vitually independent of the rate of rotation. The problems still remaining with this type of clutch are enumerated. Systems of equations describing the operating characteristics and stability are developed for all the types of clutches, and examples of their application are given. M.P.G.

**N65-12408*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

**FIELD-EFFECT TRANSISTORS AS DC AMPLIFIERS**

Floyd M. Gardner 15 Nov. 1964 20 p refs

(Contract NAS7-100)

(NASA-CR-59630; JPL-TR-32-670) OTS Prices: HC $1.00/MF $0.50

The characteristics of field-effect transistors and their operation as dc amplifiers are reviewed, followed by a discussion of circuit techniques for providing low-drift performance. Some considerations to questions of temporal stability and to methods of measuring field-effect transistor characteristics are given. A short discussion of future trends is also included. Author

**N65-12423#** Clevite Corp., Palo Alto, Calif. Shockley Research Lab.

**RESEARCH ON SOLID STATE NOISE DEVICES Second Annual Scientific Report, 1 Aug. 1963–31 Jul. 1964**

Roland H. Haitz [1964] 156 p refs

(Contract DA-49-186-ORD-1086)

(AD-607231)

This study pertains to the basic mechanisms of the avalanche breakdown in a noise diode, and their applications to the generation of large amplitude white noise with temperature independence. The following topics are presented: "Design Considerations for a Noise Diode with a Low Avalanche Pulse Rate"—equivalent circuit and diode operation, external circuit and pulse shape, calculation of the spectral voltage density, and comparison with the experimental results and discussion; "Diffusion of Minority Carriers to the Breakdown Region"; "Procedure for the Production of Noise Diodes and Preliminary Testing"; "Standard Test Procedures"; "Reproducibility of Diode Production"; "Noise Diode with Different Breakdown Voltages"; and "Noise Diode with High Pulse Rate." G.G.

**N65-12424#** Clevite Corp., Palo Alto, Calif. Shockley Research Lab.

**CONTRIBUTIONS TO THE NOISE PULSE RATE OF AVALANCHE DIODES RESULTING FROM CARRIER GENERATION WITHIN THE SPACE CHARGE LAYER, APPENDIX I**

*In its* Res. on Solid State Noise Devices [1964] p 87–127 refs (See N65-12423 03-09)

The noise pulse rate of microplasmas and uniform avalanche diodes is determined by carrier generation within the space-charge layer of the breakdown region, and by minority-carrier diffusion to the breakdown region. By suppressing the minority-carrier diffusion from bulk to breakdown region by a suitable geometry of uniform avalanche diodes, it is possible to investigate the carrier generation within the space-charge layer of a p-n junction. Three contributions to the carrier generation rate are found: (1) thermal carrier generation from generation centers, (2) reemission of carriers trapped during preceding periods of avalanche breakdown, and (3) carrier generation by internal field emission (band-to-band tunneling). Author

**N65-12425#** Clevite Corp., Palo Alto, Calif. Shockley Research Lab.

**STUDIES ON OPTICAL COUPLING BETWEEN SILICON P-N JUNCTIONS, APPENDIX II**

Roland H. Haitz *In its* Res. on Solid State Noise Devices [1964] p 128–153 (See N65-12423 03-09)

The noise pulse rate of a silicon avalanche diode is increased after another diode diffused into the same silicon slice switches to its reverse or forward conducting state. Artificial microplasmas with an extremely low background pulse rate are used to investigate this coupling mechanism quantitatively. An analysis of the experimental results leads to the conclusion that the interaction between the diodes is due to infrared radiation with a quantum energy of $<1.10$ eV. Phonon-assisted band-to-band generation rather than generation from defect centers is dominant. From measurements of optical coupling effects it is estimated that the $\gamma$-sensitivity of a silicon geiger counter is determined by direct $\gamma$-absorption within the sensitive detector volume. Recombination radiation from other parts of the crystal is negligible. For $\gamma$-radiation from a $Co^{60}$ source the sensitivity is estimated to be of the order of $10^4$ R/hr. Author

**N65-12434#** Naval Applied Science Lab., Brooklyn, N.Y. Physical Sciences Div.

**DEVELOPMENT OF TEST SET, ELECTRON TUBE, AN/USM-195 (XN-1)**

R. Decker, R. Jehle, and S. Veisel [1964] 53 p

(PR-1; AD-449570)

This report covers the design and development of a prototype model of a portable RADIAC tube tester for checking a wide variety of Geiger–Müller and associated electronic tubes presently in use. A complete set of design drawings, a proposed specification, and a proposed instruction book are included. Author

**N65-12456#** California U., Berkeley. Electronics Research Lab.
**STUDY OF CROSS-FIELD AMPLIFIERS Third Quarterly Progress Report, 15 Jan.–15 Apr. 1964**
T. Van Duzer et al [1964] 10 p ref
(Contract DA-36-039-AMC-02164(E))
(Rept.-3; AD-448492)

The following studies were made: "Noise-Figure Studies on Crossed-Field Backward-Wave Amplifiers"—analyses that could be used to transform the cathode fluctuation quantities through the drifting and accelerating cross-field regions; "Shielded-Gun Crossed-Field Amplifier"—to design a shielded-gun crossed-field amplifier and to measure its noise figure; "Noise Figure Studies on Forward-Wave Crossed-Field Amplifier"—to develop an understanding of the noise characteristics of forward-wave crossed-field amplifiers to a degree sufficient to permit appreciable noise-figure reductions; and "Cathode Region Studies on Crossed-Field Tubes"—to study the large broadband noise in long crossed-field guns from the point of view of the beam instability. G.G.

**N65-12475*#** Texas Instruments, Inc., Dallas. Apparatus Div.
**RANGER COMMAND SUBSYSTEM FOLLOW-ON Final Engineering Report No. 17-48420**
5 May 1962 43 p
(Contracts NAS7-100; JPL-950065)
(NASA-CR-59621) OTS Prices: HC $2.00/MF $0.50

This is the final engineering report on the design and fabrication of a digital command detector and a digital command decoder for the Ranger Block III command system. The component density of this equipment is obtained by the use of a modular construction for the digital building blocks. This construction technique provides a component density of 100 000 components per cubic foot, and an overall package component density of 50 000 components per cubic foot. G.G.

**N65-12493#** Naval Ordnance Lab., White Oak, Md.
**MICROCIRCUITS IN PERSPECTIVE**
J. E. Swanekamp and A. J. Cote, Jr. Aug. 1964 34 p refs
(NOLTR-64-89; AD-604586)

General information on integrated and thin-film circuits is given, along with some detailed fabrication techniques and test results on sample circuits. A general discussion of microelectronic capabilities from a circuit designer's point of view is also presented, along with recommendations and conclusions. Author

**N65-12509** Carnegie Inst. of Tech., Pittsburgh, Pa.
**SURFACE FIELD EFFECT DEVICE STUDIES FOR HIGH RESISTIVITY GALLIUM ARSENIDE. PART II: SURFACE FIELD EFFECT TRANSISTOR**
Earl J. Charlson Feb. 1964 40 p refs
(Contract Nonr-760(09))
(AD-603752)

The use of copper as a means of compensating low resistivity n-type material to high resistivity n-type material is studied. The optimum diffusion temperature for compensation can be predicted by a series of diffusions. Large-area average resistivities of as high as $4 \times 10^7$ ohm-cm were obtained using this technique. A different method for measuring the resistivity of highly compensated semiconductors ($10^5$ to $10^8$ ohm-cm) is described. In this method the semiconductor is made the dielectric of a parallel plate capacitor whose effective parallel resistance and capacitance ($R_p$, $C_p$) are measured in a high-frequency bridge. The bulk resistivity is equal to $R_pC_p/\epsilon$ provided contact effects are negligible (Appendix 1 considers contact effects). Surface field-effect transistors using high resistivity n-type single crystal GaAs (up to $10^7$ ohm centimeter) as the semiconductor are discussed. These transistors consist of two ohmic source and drain contacts of alloyed thin films of indium and nickel, a gate insulator of evaporated $SiO$, and a gate of Al. Author

**N65-12526#** Sylvania Electric Products, Inc., Woburn, Mass. Sylvania Semiconductor Div.
**PRODUCTION ENGINEERING MEASURE FOR GALLIUM ARSENIDE VARACTOR DIODE Final Report, Jun. 1, 1962-Jun. 1, 1964**
C. F. Davis, Jr. [1964] 202 p
(Contract DA-36-039-SC-86736)
(AD-604050) OTS: $6.00

The process for fabricating and testing gallium arsenide varactor diodes is discussed. The chronological development of the present process is outlined, including a summary of the engineering investigations performed and the general construction that has resulted. Test data from the preproduction and pilot production runs are tabulated and analyzed. Materials and process specifications necessary to fabricate these diodes are included. Author

**N65-12538#** Sprague Electric Co., North Adams, Mass.
**PRODUCTION ENGINEERING MEASURE FOR COLUMBIUM CAPACITORS Quarterly Report, 26 Mar.–26 Jun. 1964**
J. H. D. Folster, E. E. Holley, and A. Whitman [1964] 12 p
(Contract DA-36-039-AMC-01468(E))
(QR-4; AD-606677) OTS: $1.00

Construction of the four ratings required for the preproduction sample was continued. Manufacture of three of these ratings was completed, and they are ready for testing. Preliminary findings in the study to determine the effects of voltage and capacitance derating indicate that voltage derating can be used to achieve better leakage current levels and improved stability of this important parameter. However, it is cautioned that the leakage current behavior will still be inferior to that demonstrated by solid tantalum capacitors. Author

**N65-12584#** Aberdeen Proving Ground, Md. Ballistic Research Labs.
**A HIGH STABILITY, WIDE-FREQUENCY RANGE, ONE-TRANSISTOR, VOLTAGE CONTROLLED OSCILLATOR**
George J. Levy Jul. 1964 15 p
(BRL-Memo-1591; AD-451311)

A 10 Mc/sec transistorized, bias-stabilized VCO (voltage-controlled oscillator) for use with a tracking filter is described. The frequency-sensitive component is a type V-10 voltage-variable capacitor. A 1500 ohm thermistor in the externally heated chamber is used to stabilize the bias of the transistor over the operating temperature range of 94° to 116° F. The VCO has a frequency stability of 0.15% over the operating temperature range. The frequency VS control-signal characteristic is linear within 0.071% over a frequency deviation of ±10 kc/sec. The sensitivity is 13 kc/sec/V. A temperature-controlled chamber is used to simulate the temperature environment. Author

**N65-12588** Ecole Normale Superieure, Paris (France). Lab. de Physique
**RESEARCH ON EMISSION OF HOT ELECTRONS FROM A COLD LATTICE Technical Final Report**
J. Bok 15 Jul. 1964 112 p refs
(Contract AF 61(052)-403)
(AFCRL-64-826; AD-451666)

Work is summarized under the following headings: (1) "Hot Electron Emission from a Cold Lattice"; (2) "Effects from High Electric Fields in Thin Aluminum Films and Their Application to Electron Emission"; (3) "Measurement of the Mean Free Path for Fast Electrons in Gold and in Alumina"; and (4) "Electron Emission from a Silicon P–N Junction." P.V.E.

**N65-12591#** Naval Ordnance Lab., White Oak, Md.
**DESIGN STUDY OF A TRANSISTOR CRYSTAL OSCILLATOR USING A VOLTAGE-VARIABLE CAPACITOR FOR FREQUENCY MODULATION**
Charles A. Fisher Dec. 1964 61 p refs
(NOLTR-64-147; AD-451638)

This paper presents a design study of a variable-frequency crystal oscillator and reactance modulator for use at 20 to 22 Mc in a vhf transmitter. The oscillator is essentially the transistor equivalent of the Pierce vacuum-tube oscillator; however, several unusual design features are involved. In particular, a coil is used in series with the crystal in accordance with the design criteria developed to allow stable operation over a much wider band of frequencies than is possible with an ordinary crystal oscillator. Also, the design has the output taken from a tank tuned to the second harmonic of the oscillator frequency to minimize frequency-multiplying stages. The reactance modulator employs two silicon voltage-variable capacitors connected across one capacitive branch of the oscillator. This arrangement allows the oscillator frequency to be directly deviated by an audio signal voltage. Author

**N65-12618*#** Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.
**BRUSHLESS D.C. TORQUE MOTOR First Quarterly Report, 25 Jun.–25 Sep. 1964**
W. W. Yates and R. E. Skamfer [1964] 118 p refs
(Contract NAS5-3934)
(NASA-CR-59771; WAED64.55E) OTS Prices: HC $4.00/MF $0.75

Described is a brushless dc torque motor with characteristics that are similar to a conventional permanent-magnet torque motor for operation in a vacuum. Experimental work was performed to determine the proper design of the rotor position, the sensing device, and a squaring circuit necessary to insure that the power-transistor switches do not operate in a partially "on" state. The motor is slightly heavier than the initial estimate, being 3.1 pounds instead of 2.7 pounds, but the overall package weight will be practically the same as estimated. All of the design procedures and calculations are presented. The calculations indicate that the motor will closely approach the required performance. Author

**N65-12642#** Atomics International, Canoga Park, Calif.
**LOW FLUX NUCLEAR RADIATION EFFECTS ON ELECTRICAL AND ELECTRONIC COMPONENTS (BMI-LF-3)**
M. N. Robinson, S. G. Kimble, and D. M. Walker 1 Dec. 1964 186 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-9634) OTS: $5.00

This report describes screening tests of nuclear radiation effects on electrical and electronic components for the SNAP 2 and 8 control systems. Five transistor models, three capacitor types, and several encapsulation materials were irradiated to $10^{16}$ nvt (>0.1 MeV) and $4 \times 10^{8}$ R (gamma). The components were maintained at a temperature of 140° F and a vacuum of $5 \times 10^{-4}$ torr. Measurements were taken of electrical characteristics during irradiation, and the resulting degradation curves were plotted by computer. Author

**N65-12672#** Electromagnetic Technology Corp., Palo Alto, Calif.
**FREQUENCY CONVERTER UNITS FOR L-BAND, S-BAND, C-BAND, AND X-BAND Interim Development Report, 1–30 Sep. 1964**
William A. Edson 15 Oct. 1964 12 p
(Contract NObsr-89536)
(IDR-15; AD-607049) OTS: $1.00

A second L-band double-balanced converter was fabricated as a step toward establishing a final manufacturable design. Some problems of mechanical stability were encountered, but the results indicate that the characteristics of the initial unit can be satisfactorily reproduced. The noise figure of this unit was measured at 12 dB, 3 dB within the specified limit. An S-band double-balanced converter, based on the same design approach as that used in the L-band unit, was fabricated and tested. Except for minor deviations, it meets the conversion loss and VSWR requirements in both S- and K-band. The development of double-balanced converters for X- and C-bands is being conducted in parallel. Author

**N65-12681#** Litton Industries, San Carlos, Calif. Research Lab.
**HIGH-POWER CROSSED-FIELD AMPLIFIER Final Technical Documentary Report**
Joseph F. Hull Wright-Patterson AFB, Ohio, AF Avionics Lab., Jul. 1964 178 p refs *Its* Report.-793
(Contract AF 33(616)-6493)
(ASD-TDR-63-793; AD-607058)

Presented is a summary of a program for the development of an X-band crossed-field amplifier. The feasibility portion was primarily concerned with computer studies leading to the electrical design of the tube. A split-folded waveguide slow-wave structure was designed and fabricated as an experimental tube. Tests proved the feasibility of achieving a cw power output with reasonable gain, efficiency, and bandwidth. The X-band development work resulted in a tube with a saturated gain of 22 to 25 dB over the frequency range 8.5 to 10.7 Gc with a power output of approximately 1 kW over most of the range. The tube operates at a cathode voltage of 7.5 kV; packaged in its permanent magnet, it is 22 in. long, 4 in. wide, and 7 in. high. P.V.E.

**N65-12736#** Microwave Associates, Inc., Burlington, Mass. Semiconductor Div.
**HIGH POWER SEMICONDUCTOR PHASE SHIFTING DEVICES RELIABILITY TEST REPORT First Special Quarterly Report, 1 Apr.–30 Jun. 1964**
William W. Slavinsky, Jr. Jul. 1964 45 p refs
(Contract NObsr-87291)
(AD-603162) OTS: $2.00

The use of high-power semiconductor devices for phase shifting in array antennas is being considered. The large number of these components in a practical system makes reliability data important. Progress made within the last study interval is reported. This includes the continuation of the life tests through the 1500 hour readings. Data reduction shows that the leakage current has a decreasing failure rate with time, early leakage failures should be screeened out by a properly designed burn-in, alternate forward and reverse bias is a more severe test than continuous reverse bias, and capacitance variations decrease as frequency increases. Author

**N65-12738#** Royal Aircraft Establishment, Farnborough (Gt. Brit.)
**A SEMICONDUCTOR SWITCH FOR DIRECT CURRENT GENERATORS [POLUPROVODNIKOVYI KOMMUTATOR GENERATOROV POSTOYANNOGO TOKA]**

A. F. Krogeris London, Min. of Aviation, Aug. 1964 11 p refs Transl. into ENGLISH from the publ. "Poluprovodnikovyi Kommutator Generatorov Postoyannogo Toka" Riga, 1961 (RAE-Trans-1075)

A review of the development of static switching elements is given, with special reference to their use as switching devices to replace the commutator in dc generators. Present-day development of high-voltage germanium and silicon rectifiers has made practicable the design of a static commutator that eliminates the brushes in a dc machine. This gives improved reliability and also reduces maintenance. Alternative brushless dc machine configurations can take the form of a synchronous machine having a solid rotor and a rectified output. Such a machine is described having a claw-shaped rotor and a construction that allows all windings to be mounted on the stator. This machine had an output of 7 kW and was intended for rail-wagon applications. A later machine of similar output was designed to supply both ac and dc outputs. By comparison, it is shown that experimental brushless machines are comparable in size and weight to conventional commutator machines. Author

**N65-12745#** Michigan U., Ann Arbor. Electron Physics Lab.
**EVALUATION OF HIGH-THERMAL-CONDUCTIVITY CERAMICS FOR COOLING R-F STRUCTURES Technical Report No. 78**
H. K. Detweiler and J. E. Rowe Oct. 1964 124 p refs
(Contract AF 33(615)-1553)
(Rept.-06349-5-T; AD-451672)

A theoretical and experimental investigation into the use of high-thermal-conductivity materials in microwave devices is described. It has been found that, by replacing the usual ceramic support rods and glass or metal vacuum envelope with a beryllia structure, the helix is capable of dissipating considerably more power for a given helix temperature. Theoretical predictions of power-handling capability are presented for beryllia-supported helices designed for operation at various frequencies. A brazing technique is described that was developed to overcome a thermal contact problem encountered in early dc power tests. Results of subsequent tests on a 6-inch S-band helix brazed into a fluted BeO tube are presented. Experimental results show that the brazed helix–BeO tube structure compares favorably with other conventional methods in regard to rf characteristics, i.e., insertion loss, DLF, and matching. Author

**N65-12767#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
**AN EXPERIMENTAL INVESTIGATION OF GERMANIUM DIODES OF VARIOUS GEOMETRIES AS INFRARED MODULATORS**
Larry Alan Darda (M.S. Thesis) Aug. 1964 58 p refs
(GE(EE)64-4; AD-607034)

Two newly designed germanium diodes are investigated to determine their infrared absorption properties as a function of current. Both designs work well but can be improved through better junction formation methods and through the use of lower resistivity material. It is shown that the process of free-carrier absorption is independent of the size or shape of the device, thus allowing considerable freedom in selecting more compact and efficient designs. A new design is proposed that includes the best features of the rectangular and trapezoidal modulators. Author

**N65-12768#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio.
**CHARACTERISTICS OF A PHOTON COUPLED AMPLIFIER**
William F. Grieder (M.S. Thesis) Aug. 1964 62 p refs
(GA/EE/64-5; AD-607032)

This report contains a study of the small-signal characteristics of a photon coupled amplifier (PCA). An af model for the PCA is proposed based on measured static characteristics from six prototype units. The model is used to derive performance characteristics of a common emitter PCA configuration. Results indicate that PCA output impedance and voltage gain are high, whereas input impedance and current gain are low, and that voltage gain can exceed 2000 for high resistive loads. Theoretical performance is verified with measured data from a breadboard circuit. Temperature effects on PCA performance are discussed using experimental data. Author

**N65-12787#** Atomic Energy of Canada Ltd., Chalk River, Ontario.
**A DUAL CHANNEL CURRENT REGULATOR FOR USE WITH MAGNETIC LENSES**
J. P. D. O'Dacre Sep. 1964 19 p refs
(AECL-2061)

A dual-channel current regulator is described. The technique employed is that of a cathode-follower current controller with a feedback amplifier. Current change is sensed by means of a resistor in series with the load. The current range of each channel is 0 to 1 A dc. A 10% change in the current supply line voltage produces a variation of less than 0.2% of full scale. The average short-term drift (1 hour) is $< \pm 1\%$, the long-term average drift (1 week) is $< \pm 2\%$. Author

**N65-12791#** Frequency Electronics, Inc., Astoria, N.Y.
**ELECTRON RADIATION STUDY OF QUARTZ CRYSTALS AND OSCILLATORS**
Morris Meltzer and Millard B. Prisant [1964] 29 p

The work performed in this study has attempted to determine the worst possible frequency drift that could occur in a standard frequency electronics oscillator, exposed to the radiation in the Van Allen belts for a year. Five oscillators and five crystals were exposed to the electron beam from a Van De Graff generator. The total dosage received in several minutes was equivalent to that expected in the Van Allen belts for a whole year. Exposure to radiation causes an oscillator's frequency to shift negatively. There is no recovery from this shift, after the radiation is removed. The oscillator's aging rate is also affected by radiation. Its new pattern is typical of that of a raw crystal. The crystal ages positively at a decaying exponential rate. It starts out steeply positive and gradually flattens out. After many weeks of continuous operation, the aging rate of an exposed crystal is equal to its aging rate directly before the exposure. Author

**N65-12852#** Bernard Electronics Co., Washington, D.C.
**SOLID-STATE LIGHTING CONTROLLER Final Report**
Bernard R. Boymel Jun. 1964 27 p
(Contract FA-WA-4654)
(RD-64-112)

This report describes the development of a solid-state lighting controller for use with up to 24-kW airport series-lighting circuits. Silicon-controlled rectifiers make possible continuous control of lights from zero to full brilliance utilizing less than 5 watts of control power. Tests were performed demonstrating compliance with the design specification. Author

**N65-12882#** Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati
**AN ELECTRIC TRANSISTORIZED CIRCUIT FOR USE IN ELECTROSYNCHROTRON EXPERIMENTS [UNA CATENA ELETTRONICA TRANSISTORIZZATA PER ESPERIENZE CON L'ELETTROSINCROTRONE]**

G. Penso and V. Silvestrini 30 Jul. 1964 22 p (In ITALIAN *Its* Nota Interna No. 257
(LNF-64/45)

An electronic circuit, consisting of a limiter, connector, discriminator, and a gate is described. The circuit is to be used in connection with experiments on the sychrotron at Frascati and has been transistorized to improve its reliability. D.E.R.

**N65-12910#** Philco Corp., Lansdale, Pa.
**MICROMINIATURE PROGRAMMABLE LOGIC ELEMENTS Final Report**
G. L. Schnable Aug. 1964 49 p refs
(Contract AF 19(628)-260)
(AFCRL-64-832; AD-608525)

The ultimate feasibility of the elements was demonstrated by their incorporation into the digital section of a pattern recognition system designated the Parapropagation Pattern Classifier (PPC). This phase was a study of the capabilities and limitations of various techniques for obtaining improved isolation in silicon monolithic microcircuits. The $SiO_2$ isolation process is described in detail, process variations are indicated, and the results of the recommended process are illustrated in a series of photomicrographs. Author

**N65-12922#** Bendix Corp., Southfield, Mich. Research Labs. Div.
**EXPLORATORY DEVELOPMENT OF THE Q-FACTOR TECHNIQUE Second Quarterly Progress Letter, Period Ending 30 Sep. 1964**
Max Frank 10 Oct. 1964 47 p
(Contract AF 29(601)-6316)
(Rept.-2734; AD-608961)

Gamma radiation tests were performed on 2N1613 transistors to study differences in gain degradation between passive and various transistor operating conditions during irradiation. The influence of emitter current alone and collector voltage alone was investigated to determine how each of these parameters behave, and to explain the combined effect observed. The effects on gain degradation of different temperatures and measurement at different current levels were also studied in the gamma tests. The results of several active-to-passive gain degradation comparisons for a neutron exposure are included. Author

**N65-12925#** Technische Hochschule Darmstadt (W. Germany).
**ON THE ATTENUATION OF A COAXIAL UNDERWATER TELEPHONE CABLE [UBER DIE DAMPFUNG KOAXIALER FERNSPRECH-SEEKABEL]**
Helmut Riedel (Ph.D. Thesis) [1963] 91 p refs In GERMAN

Analytical and fabrication methods for the design of long underwater communication cables with improved attenuation properties are presented. This is especially important for those cables containing an increased number of amplifiers. The values for the internal conductors were found by the consideration of the various systematic and hidden differential coefficients that influence the attenuation ability, and the results were incorporated in the technical development process. Several fabrication details of these improved attenuation cables are presented. The newly developed cable was found to handle a satisfactory work load. G.G.

**N65-12964#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics
**DEVELOPMENT OF A LARGE-VOLUME SUPERCONDUCTING SOLENOID**
Lucien J. Donadieu (Ph.D. Thesis) 16 Oct. 1964 136 p refs
(Contract DA-36-039-AMC-03200(E); Grant DA-SIG-36-039-61-G14; NSF G-24073)
(TR-427; AD-608445)

Problems encountered in the development of large-volume superconducting solenoids have been investigated in the light of the experience induced by the realization of a particular prototype (8.0 in. in diameter, 4 ft long, 20 kilogauss at room temperature). The current-field characteristics of some useful superconducting materials (Nb, Mo-Re, Nb-Zr) have been measured; the results are discussed in terms of recent theories of superconductors. The spurious loss of the resistanceless state of a superconducting solenoid was thoroughly investigated. Starting from the steady-state mechanisms of the quenching propagation in wire, the equations for current decay, voltage surge, wire-temperature rise, and energy transfer are derived; results of calculations for the prototype solenoid are presented. In the design of the prototype solenoid the most important topics covered are field calculation for multicoil solenoids; magnetic stresses and magnetic energy; quenching process for multicoil solenoids; steady-state heat transfer caused by residual gas, thermal radiation, and conduction; and transient heat transfer, particularly during cooling down and quenching. Author

**N65-12966#** Raytheon Co., Burlington, Mass. Spencer Lab.
**X-BAND ELECTROMAGNETIC AMPLIFYING LENS Technical Documentary Report, Nov. 25, 1963–Feb. 25, 1964**
J. Skowron and N. Heenan Griffiss AFB, N.Y., RADC, Aug. 1964 37 p refs
(Contract AF 30(602)-2892)
(RADC-TDR-64-249; AD-607428)

This report covers construction and evaluation of an experimental electromagnetic amplifying lens (EAL) at X-band that will demonstrate the practicality of the EAL principle, and to carry out a theoretical and experimental investigation of fabrication techniques and tube components for the embodiment of the EAL principle in a practical superpower millimeter-wave oscillator or amplifier. A decision was reached to incorporate in the EAL a new cathode that would provide an accurate cathode–anode spacing; this design was largely completed. Tests were conducted on the EAL at 5250 to 5650 Mc/sec to determine the effects of driving the tube at these frequencies. Postoperative analysis of the disassembled EAL indicated that severe arcing and melting of copper occurred within the tube. The cathode redesign was modified to eliminate arcing problems if possible. Author

**N65-12967#** General Telephone and Electronics Labs., Inc., Bayside, N.Y.
**STUDY OF FAILURE MECHANISMS IN HIGH-POWER RADIO-FREQUENCY-GENERATING DEVICES Final Report, 30 Apr. 1963–29 Apr. 1964**
M. Friedman Axler and R. A. Hein (Sylvania Elec. Co.), Griffiss AFB, N.Y., RADC, Sep. 1964 96 p refs
(Contract AF 30(602)-3018)
(TR-64-256.12; RADC-TDR-64-290; AD-608362)

An investigation was carried out to determine failure mechanisms caused by residual gases in traveling-wave tubes and to study means of eliminating these gases with the aim of improving tube reliability. The gas ambient of three types of operating tubes and of individual tube subassemblies and components was examined with an omegatron mass spectrometer permanently attached to the unit under test. Electrical test parameters of the traveling-wave tube and their relation to the gas ambient are presented. For tubes incorporating oxide-coated cathodes, decreases in cathode activity are correlated with integrated total and partial pressures in the operating tube.

Contributions made by various processed tube components and subassemblies to the gas ambient of the operating vacuum tube are described. Author

**N65-12969#** Cutler-Hammer, Inc., Deer Park, N.Y. Airborne Instruments Lab.
**MILLIMETER AND SUBMILLIMETER COMPONENT DEVELOPMENT First Quarterly Report**
J. J. Taub, J. Cohen, H. J. Hindin, G. Kurpis, F. R. Arams et al Griffiss AFB, N.Y., RADC, Sep. 1964 94 p refs
(Contract AF 30(602)-3343)
(RADC-TDR-64-331; AD-608658)

Techniques for designing filters, ferrite devices, diode mounts, and radiation detectors in oversize rectangular waveguide were investigated. A theoretical analysis of filters composed of iterations of dielectric slabs was made for arbitrary angles of incidence in addition to a study of effects of small dielectric dissipation losses. The results for three and six iterations for various dielectric constants are presented. A prototype two-port dielectric slab filter was constructed for operation at 33-Gc, and the experimental results are in reasonable agreement with the expected theoretical values. This design can be scaled to operate in the submillimeter-wavelength region. Experiments using wire mesh as the grating elements in bandpass filters yielded poor values of unloaded Q. Better results are expected with a circular-hole grating deposited on a quartz substrate. Author

**N65-12975#** Bell Telephone Labs., Inc., Murray Hill, N.J.
**ENGINEERING SERVICES ON TRANSISTORS Fifth Quarterly Progress Report, 1 Apr.–30 Jun. 1964**
J. Kocsis, B. T. Murphy, and R. L. Pritchett 30 Sep. 1964 43 p refs
(Contract DA-36-039-AMC-02237(E))
(Rept.-17; AD-451133)

Several planar germanium transistors with 0.2-mil-wide stripes and 0.1-mil stripe separation were encapsuled and showed typical d.c. $\beta$'s of 40 and 50 and stable readings of power gains in a simple amplifier of 10 to 15 dB at 2 Gc. A typical gain figure of about 27 dB was obtained at 1 Gc. The cost per component of a monolithic integrated circuit consisting of an array of identical components was calculated, and an optimal chip size of between 20 and 60 mils square for a wide range of parameter values was established. Arrays of identical logic gates fit the circuit model quite closely, and the curves indicate that the cost per gate in reasonably densely packed arrays can be less than the cost of a discrete transistor. G.G.

**N65-12994#** Utah U., Salt Lake City. Microwave Device and Physical Electronics Lab.
**A 36—40 kMc COUPLED LADDER BACKWARD-WAVE OSCILLATOR Technical Documentary Report, Jul. 1962–Jul. 1964**
R. W. Grow and L. S. Bowman Wright-Patterson AFB, Ohio, AF Avionics Lab., Oct. 1964 57 p refs
(Contract AF 33(657)-8677)
(AL-TDR-64-225; AD-608214)

Experimental results are reported for a four coupled-ladder backward-wave oscillator designed for the frequency band from 36 to 40 kMc. The voltage ranged from 14 000 to 20 000 volts and the power output was in excess of 20 W at 40 kMc. The electron beam was obtained by a convergent confined-flow cylindrical electron gun to eliminate beam rotation. The solid electron beam 0.116 in. in diameter flooded the ladder circuit with a measure current density of about 8 a/cm$^2$. The output terminal was constructed with the individual ladders becoming ridges of a ridge waveguide. This technique was utilized to phase lock the waves on each ladder to obtain output only from the longitudinal mode. Good agreement was obtained between the theoretical and experimental starting current, tuning curve, and power output. Author

**N65-13050#** Army Signal Research and Development Agency and Lab., Fort Monmouth, N.J. Army Electronics Labs.
**$TE^{o}_{01}$ CROSS-GUIDE ISOLATOR**
Elmer Freibergs and Richard A. Stern Jul. 1964 23 p refs
(ECOM-2430; AD-608617)

A cross-guide or cruciform-waveguide ferrite resonance load isolator was developed for use with the existing circular waveguide $TE_{01}$ mode components. This unit provides reverse-to-forward attenuation ratios in excess of 15:1 over an 8% bandwidth centered at 35.22 Gc. A semiquantitative mathematical analysis of the electromagnetic waves propagating in the empty cruciform waveguide was performed, and expressions for the field components were derived. Author

**N65-13056#** Applied Science Associates, Inc., Valencia, Pa.
**THE MAINTENANCE TASK SIMULATOR-1 (MTS-1): A DEVICE FOR ELECTRONIC MAINTENANCE RESEARCH Final Report, Oct. 1962–Jun. 1964**
Thomas K. Elliott and John D. Folley, Jr. Wright-Patterson AFB, Ohio, AMRL, Oct. 1964 42 p
(Contract AF 33(657)-10052)
(AMRL-TR-64-99; AD-608745)

The simulator is a low-priced task-simulation device, specially constructed for research on performance aids used in conjunction with electronic maintenance. The device can present many complex electronic control-display panel configurations. The control-display panel is composed of a variety of modules that may contain a control or display or be blank. The device also contains sensing and recording circuitry, which provides a time-referenced record of control positions and sequence of manipulations by the subject. The device can support such research as determining the various skills and concepts required by the technician in performing various levels of electronic maintenance and developing effective techniques for evaluating the proficiency of electronic maintenance personnel. Author

**N65-13058#** Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.
**SILICON CARBIDE, 500°C POWER RECTIFIERS Final Report, 1 Jul. 1962–31 Aug. 1964**
R. B. Campbell, J. R. Davis, Jr., and L. J. Kroko Wright-Patterson AFB, Ohio, AF Avionics Lab., Nov. 1964 185 p refs
(Contract AF 33(657)-8719)
(AL-TDR-64-253; AD-608623)

The preparation of 500° C SiC rectifiers having a forward current capability of 10 A (half-wave average) while sustaining a peak reverse voltage of 150 V has been shown practicable. Several crystal growth techniques were investigated for the fabrication of power rectifiers; the sublimation, thermal reduction, and modified Czochralski methods. Methods for obtaining larger crystals and controlling nucleation have been studied in the sublimation method. Crystals of high purity up to 15 mm across have been grown. The thermal reduction and modified Czochralski methods investigated the feasibility of growing SiC ribbon or sheets using a hexagonal SiC platelet as a seed. Junctions were formed in SiC by sublimation, diffusion, and epitaxial growth techniques. The sublimation-grown junction

method was successful in preparing crystals for high current capacity rectifiers. Sample rectifiers have been prepared with a forward current capacity of 8 A, and a laboratory demonstration of a 10 A unit has been achieved. The epitaxial methods require further development to be practicable. Device fabrication techniques, such as lapping, etching, contacting, and encapsulation have been developed for 10 A rectifiers. The use of a new type of tungsten backing plate with grain texture parallel to the direction of heat flow has reduced the thermal impedance of the device. Author

**N65-13079#** General Electric Co., Schenectady, N.Y. Tube Dept.
**HIGH-POWER TRAVELING-WAVE MULTIPLE-BEAM KLYSTRON Eighth Quarterly Progress Report, 1 Apr.–30 Jun. 1964**
R. A. Dehn, J. S. Hickey, W. J. Pohl, and J. R. Krasnakevich [1964] 57 p refs
(Contract DA-36-039-AMC-00007(E); ARPA Order 345-62; Proj. Defender)
(Rept.-8; AD-452457)

Progress in evaluating the principle of the traveling-wave multiple-beam klystron (TWMBK) and in demonstrating the feasibility of the TWMBK as a long-life broadband transmitting tube is reported. A high-power tube was developed to the point where cold testing and the mechanical design are complete, and construction is proceeding. Window tests for both a high-power and continuous-wave TWMBK are described. A continuous-wave tube design was modified so that 12 beams only can be used. Testing on the circularly symmetric output cavity indicated the need for a $TM_{01}$ load. The load was constructed and is described. An optimum R/Q cavity for the multiple-beam klystron (MBK) broadbanding tube was designed. P.V.E.

**N65-13086#** Atomics International, Canoga Park, Calif.
**UNIFORM WORK FUNCTION CATHODE STUDIES Sixth Quarterly Report**
M. N. Huberman Wright-Patterson AFB, Ohio, Res. and Technol. Div., Aug. 1964 25 p refs
(Contract AF 33(657)-8726)
(AI-64-213; AD-449648)

Continued studies of vapor-deposited tungsten have confirmed that (100) orientations can be reliably and reproducibly obtained. No great change in preferred orientation, except for a possible broadening of the pole figure peak from 10° to 20° was observed after operating a vapor-deposited cathode for 40 hours at 2000° K combined with occasional rapid thermal cycling to room temperature and 2800° K. Emission microscope studies have shown that uniform work function areas can be produced in a vapor-deposited cathode after flashing at 2800° K. Allowing the cathode to cool and adsorb gas on surface produces a relatively nonuniform work function. Author

**N65-13087#** Philco Corp., Lansdale, Pa.
**RESEARCH AND DEVELOPMENT TO OBTAIN SEMICONDUCTOR JUNCTION MIXER DIODES FOR COUNTERMEASURES EQUIPMENT Final Engineering Report, 26 Jun. 1963–26 Jun. 1964**
[1964] 88 p
(Contract NObsr-89420)
(H-102; AD-450166)

The basic program goal, an overall receiver noise figure of 7.0 dB at 9375 Mc, was met by diodes using aluminum–germanium alloyed junctions in conjunction with the modified microplanar structure. Two units with $NF_o$ values of 7.0 dB or less were fabricated, and a large number of units were produced that approach the goals. Of the 20 diodes delivered, all had values less than 7.8 dB, with over 50% exhibiting $NF_o$ values below 7.5 dB. Tests made to determine the potential of the diode in other microwave mixing and detecting applications show that the diode can be used to good advantage in video detector, power monitor, and Doppler mixing applications. D.S.G.

**N65-13104#** Atomics International, Canoga Park, Calif.
**LOW FLUX NUCLEAR RADIATION EFFECTS ON ELECTRICAL AND ELECTRONIC COMPONENTS (BMI-LF-3)**
M. N. Robinson, S. G. Kimble, and D. M. Walker 1 Dec. 1964 188 p
(Contract AT(11-1)-GEN-8)
(NAA-SR-9634)

This report describes screening tests of nuclear radiation effects on electrical and electronic components for the SNAP-2 and SNAP-8 control systems. Five transistor models, three capacitor types, and several encapsulation materials were irradiated to $10^{16}$ nvt (>0.1 MeV) and $4 \times 10^8$ R(gamma). The components were maintained at a temperature of 140° F and a vacuum of $5 \times 10^{-4}$ torr. Measurements were taken of electrical characteristics during irradiation, and the resulting degradation curves were plotted by computer. Author

**N65-13147#** Litton Industries, San Carlos, Calif. Research Lab.
**RESEARCH ON NOISE IN CROSSED-FIELD GUNS Quarterly Report, 1 Jul.–30 Sep. 1964**
R. P. Wadhwa 20 Oct. 1964 38 p refs
(Contract NObsr-89546)
(QR-5; AD-608594)

The design of the noise tranformer at the exit of the short Kino gun is briefly described. Some results of the simulation of the velocity jump configuration on the precision resistance network analog are discussed. Design of the high-power gun is briefly summarized. Noise-figure calculations are described for two different tubes. The calculated noise-figure values are higher than the experimental values, although there is good qualitative agreement. The difference in the noise-figure values for the two cases is correlated with the difference in the diocotron gain in the two guns. It is found that transverse velocity and space-charge fluctuations contribute significantly to the total noise figure. Author

**N65-13151#** National Semiconductor Corp., Danbury, Conn.
**PRODUCTION ENGINEERING MEASURE TO IMPROVE PRODUCTION TECHNIQUES AND INCREASE THE RELIABILITY OF THE 2N328A TRANSISTOR Quarterly Progress Report, 31 Mar.–30 Jun. 1964**
R. R. Rau [1964] 29 p
(Contract DA-36-039-AMC-01480(E))
(QPR-4; AD-608583)

This report is a review of the work on improving the reliability of the pnp silicon-alloy transistor type 2N328A. The output of the etch wheel has continued to be monitored by using the daily yield at dry-line test box location. The oxygen analyzer is presently being used to monitor the gas at three locations in the final assembly line. More aluminum evaporated units were fabricated. The best slices gave good 2N328A yield as well as a more than adequate $BV_{CEO}$ sort yield. Devices made from evaporated slices with smaller emitters and collectors gave lower yields. The reason for this problem is not yet known. A few grounded collector units were made using an epitaxially deposited junction and an n+ ring to allow an aluminum contact to be made for the base. Author

**N65-13152#** American Biophysics Research Lab., Colmar, Pa.
**MICROMINIATURIZED ELECTRONICS IN BIOLOGY AND MEDICINE**
C. G. Reinhardt, Jr. [1963] 56 p refs *Its* ABRL Monograph Ser. No. 1
(Contract Nonr-3676(00))
(AD-405845)

A brief semitechnical description of the methods and techniques of microelectronics is presented. Transducers and power sources are treated. Examples and applications of microminiaturized telemeters to specific biological problems are shown. The limitations of present microminiaturization techniques as applied to biotelemetry are discussed, and conclusions are provided for the development of future biotelemeters. Author

**N65-13155#** Melpar, Inc., Falls Church, Va.
**2000°F POWER WIRE FOR AEROSPACE ENVIRONMENT Final Report, 1 Apr. 1963–30 Sep. 1964**
K. M. Zwilsky, N. Fuschillo, H. Hahn, P. J. Lare, J. L. Pentecost et al Wright-Patterson AFB, Ohio, AF Aero Propulsion Lab., Nov. 1964 81 p refs
(Contract AF 33(657)-11046)
(AFAPL-TR-64-127; AD-608471)

Twenty-two-gage and twelve-gage power wires were fabricated using rhodium conductors, magnesium oxide insulation, platinum sheathing, and alumina end seals. The wire systems maintained their electrical integrity through a variety of environmental tests including vibration, mechanical shock, acceleration, humidity, vacuum, and nuclear radiation. The wires were operated successfully at temperatures up to and including 2000° F. Rated current was determined and assigned as 10 A for 22-gage and 60 A for 12-gage wires. The wires passed the final cyclic test of carrying rated current at room temperature for 2 hours, at high vacuum for 25 hours, and at a reduced pressure at 2000° F for 3 hours. Author

**N65-13162*#** Westinghouse Electric Corp., Lima, Ohio. Aerospace Electrical Div.
**IMPROVED MAGNETIC COMPONENTS FOR STATIC INVERTERS AND CONVERTERS Fifth Quarterly Report, Jun. 28–Sep. 27, 1964**
R. E. Mc Vay et al [1964] 52 p refs
(Contract NAS3-2792)
(NASA-CR-54146; WAED64-59E) OTS Prices: HC $2.00/MF $0.50

A literature review was made on magnetic materials for use in improved magnetic components for static inverters and converters. The magnetic materials covered were grain-oriented silicon steels and high permeability Co-Fe and Ni-Fe alloys. The effects of the following environments were considered: temperature, charged particle irradiation, high vacuum, vibration and shock, acoustical noise, and processing. Conclusions drawn from the results of the literature review included the following: (1) There is limited information on the effects of shock, acoustical noise, vibration, temperature, Van Allen radiation, and processing on magnetic materials. (2) The environments most likely to affect magnetic materials, based on the information to date, are temperature, processing variables, noise, and vibration. P.V.E.

**N65-13164#** Army Engineer Research and Development Labs., Fort Belvoir, Va.
**A STUDY OF FATIGUE IN SILVER-OXYGEN-CESIUM PHOTOCATHODES**
P. G. Borzyak, V. F. Bibik, and G. S. Kramarenko [1964] 16 p refs Transl. into ENGLISH from Radiotekhn. i Elektron. (Moscow), no. 3, 1956 p 358–369
(T-1746; AD-606168)

The article gives experimental results on fatigue of silver–oxygen–cesium photocathodes that do not correspond to existing ideas as to the nature of this phenomenon. There are indications that a major role is played here by volume changes in the oxygen–cesium films due to the effect of illumination. Author

**N65-13168#** General Electric Co., Auburn, N.Y. Rectifier Components Dept.
**THE RESEARCH AND DEVELOPMENT OF HIGH CURRENT AND HIGH VOLTAGE SILICON CONTROLLED RECTIFIERS, DEVICE D Quarterly Progress Report, 12 Jun.–12 Sep. 1964**
[1964] 62 p refs
(Contract NObsr-87648)
(QPR-1; AD-449380)

The design for the initial model of a very high voltage, high-current inverter-type thyristor was established, and the construction of samples was begun. Progress is reported in the fabrication of subassemblies, in setting up evaluation equipment, in preliminary characterization of the device, and in theoretical studies of turn-on phenomena. The evaluation of the samples in converter, inverter, and time-ratio-control circuits was begun. Preparations are reported for evaluation of the device under actual operating conditions. The specific circuits and evaluation methods that will be used are discussed in detail. D.E.W.

**N65-13180#** Joint Publications Research Service, Washington, D.C.
**ADVANCES IN MICROELECTRONICS**
R. Svoren' 24 Dec. 1964 14 p Transl. into ENGLISH from Nauka i Zhizn' (Moscow), no. 10, Oct. 1964 p 11–17
(JPRS-27979; TT-64-51995) OTS: $1.00

Two microminiature radio receivers, the Leningrad "Era" and the Moscow "Micro", are described, both receivers have smooth tuning on long waves (the Micro has it on medium waves also), and both are assembled using a direct amplification circuit and five transistors. Both contain thin tape circuits to which miniature transistors, a magnetic antenna, and a tuning condenser are attached. Thin tapes are prepared from pairs of conductor, semiconductor, or insulating materials; by using figured stencils, tape layers of varying sizes and shapes can be made. The parts and circuits can be arranged one on top of another, achieving a density of installation with thin tapes that is commensurate with the density of solid circuits. D.S.G.

**N65-13204#** Army Engineer Research and Development Labs., Fort Belvoir, Va.
**NEW OXYGEN-SILVER-CESIUM PHOTOCATHODES**
N. S. Khlebnikov and P. A. Sinitsyn [1964] 8 p refs Transl. into ENGLISH from Zh. Tekh. Fiz. (Leningrad), v. 10, no. 22, 19[illegible] p 1919–1923
(T-1728; AD-606165) OTS: $1.00

A method for manufacturing oxygen–silver–cesium cathodes, along with several of their properties is described. Discussed in particular are "Integral and "Red" Sensitivities and Spectral Properties of [Ag-O-Cs]-Ag Cathodes"; "Transition of [Ag-O-Cs]-Ag Cathodes to a Steady State"; and "Fatiguing of [Ag-O-Cs]-Ag Cathodes." The [Ag-O-Cs]-Ag photocathodes described differ from ordinary [Ag-O-Cs] cathodes in spectral response, in a noticeable shift of the infrared peak toward the ultraviolet, in higher sensitivity in the 6000- to 4000-Å region and in very slight fatiguing with high integral sensitivity. P.V.E.

N65-13229# Lewis (E. B.) Co., Inc., East Hartford, Conn.
**PRODUCTION ENGINEERING MEASURE Quarterly Report, 1 May–1 Aug. 1964**
Robert P. Mc Comb [1964] 26 p ref
(Contract DA-36-039-SC-86737)
(QR-8; AD-450697)

The AT cut crystals for filter application operating on the third overtone at frequencies of 45 Mc/sec and 70 Mc/sec are evaluated. The equivalent resistance and unwanted mode distribution for various electrode diameters were investigated at 45 Mc/sec. The evaluation of crystal units CR-(XM-46)A/U operating at 70 Mc/sec is given. The problems of parameter measurements at 70 Mc/sec are discussed and possible solutions given. Author

N65-13272*# Librascope Inc., Glendale, Calif. Reliability Dept.
**TEST ON 2N2369, NPN SILICON EPITAXIAL TRANSISTORS MANUFACTURED BY FAIRCHILD SEMICONDUCTOR**
Frank E. Haskins and L. E. Trempe 24 Apr. 1964 125 p Prepared for JPL
(Contracts NAS7-100; JPL-950230)
(NASA-CR-59908; TR-7-0057) OTS Prices: $4.00/MF $1.00

The results of a test program to determine the effects of a sequence of environments on the electrical parameters of a group of 2N2369 transistors are presented. The environmental tests consisted of temperature effects, temperature storage, thermal and mechanical shock, vibration, acceleration, humidity, low temperature, and operating life. The tests are described in detail, failures are classed as catastrophic or degradation types, and all results are tabulated and discussed. D.E.W.

N65-13285*# Atomics International, Canoga Park, Calif.
**INVESTIGATION OF CURRENT DEGRADATION PHENOMENON IN SUPERCONDUCTING SOLENOIDS First Quarterly Progress Report, Jul. 15–Oct. 15, 1964**
L. C. Salter, Jr. [1964] 28 p refs
(Contract NAS8-5356)
(NASA-CR-59651) OTS Prices: HC $2.00/MF $0.50

A one-turn loop of 0.010-in.-diam Nb–25% Zr wire was tested in time-varying transverse magnetic fields in an attempt to see rapid or catastrophic flux penetration. A one-turn Cu search coil was used to monitor the field. Flux perturbations were seen but were finally attributed to localized flux changes in the superconducting solenoid used to supply the external field. In a second experiment, the multiprobe solenoid was driven normal in external fields between 0 and 18.7 kG. The location of the normal region moved progressively from the high-field inner windings of the multiprobe coil to the geometrical ends of the coil as the external field ranged from zero to maximum. Several 0.010-in.-diam Ti-22 at.% wires were drawn and heat treated to provide a variety in metallurgical structure and critical currents. Twenty samples were heat treated, and seven of these were subjected to metallography and critical current density versus transverse field tests. Author

# 10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N65-12352# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**SCATTERING OF POWER IN COAXIAL LOAD WITH EXTERNAL CONDUCTOR OF CYLINDRICAL FORM**
T. L. Zalutskaya and L. Ye. Pecherey *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 5–9 refs (See N65-12351 03-34)

A formula for determining the power loss along a coaxial load (e.g., a coaxial cable) short-circuited at the end is derived. The power absorption is found to depend upon the relationship between the length of the load and the wavelength of the signal. P.V.E.

N65-12368# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**BASIC FEATURES OF ENGINEERING CYBERNETICS**
V. V. Solodovnikov *In its* Autom. Control and Computer Tech. 25 Aug. 1964 p 3–25 refs (See N65-12367 03-34)

After drawing an analogy between living organisms and informational machines and defining engineering cybernetics as the synthesis of informational machines capable of realizing algorithms and executing the functions depicted by them, the theoretical bases of engineering cybernetics are discussed. These include (1) information theory—processes of transmission of information; (2) theory of logical machines and computers—methods of conversion of information in accordance with given algorithms; and (3) theory of automatic control—methods of use of information for execution of purposeful actions. M.P.G.

N65-12369# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CERTAIN QUESTIONS OF SYNTHESIS OF SAMPLED DATA, SERVO SYSTEMS WITH STATIONARY RANDOM INPUTS**
L. T. Kuzin *In its* Autom. Control and Computer Tech. 25 Aug. 1964 p 26–63 refs (See N65-12367 03-34)

The use of the z-transform device for solution of problems of synthesizing servosystems with random action is described. A block diagram of a typical, sampled data servosystem, such as the range servomechanism of a pulse radar system, is considered. Using the z-transform, formulas are derived for spectra of various signals and transfer functions of sampled data systems of different types. The influence of a statipnary random signal on a sampled data system is considered. An attempt is made to generalize and apply the findings of Wiener to sampled data systems, and an optimum function for one broad class of input signals is derived. The question of realization of an optimum transfer function by different sampled-data servosystems is discussed. M.P.G.

N65-12370# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ON SELECTING PARAMETERS OF SELF-EXCITED AUTOMATIC CONTROL SYSTEMS**
Ye. P. Popov *In its* Autom. Control and Computer Tech. 25 Aug. 1964 p 64–91 refs (See N65-12367 03-34)

One variant of the method of harmonic balance, harmonic linearization, is described for determining the values of frequency and amplitude of the natural oscillations of self-excited automatic systems. The dependence of the frequency and amplitude of the oscillations upon certain parameters of the system is investigated to determine desirable values of the parameters for systems whose basic regime is self-excited, and to determine the boundary of the appearance of natural oscillations in systems in which oscillations are possible but whose normal mode

of operation is in stable equilibrium. The method used consists of expansion of a nonlinear periodic function into a harmonic Fourier series, thereby reducing the nonlinear differential equation to an equation that can be investigated by linear means. M.P.G.

**N65-12371#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**COMPLETE "FREQUENCY" DESCRIPTION OF RANDOM PROCESSES AND CERTAIN PROBLEMS OF PERFORMANCE OF CONTROL SYSTEMS**
S. Ya. Rayevskiy *In its* Autom. Control and Computer Tech. 25 Aug. 1964 p 92–113 refs (See N65-12367 03-34)

The statistical properties of a random process are described in "frequency" language as distinguished from the "time" description usually employed. Thus, the random process is characterized not by distribution functions or moments of a random function of time $X(t)$ but by statistical characteristics of a complex random function $C(J\omega)$, which is the spectrum (Fourier transform) with respect to $X(t)$. Transformation of the statistical characteristics with linear transformation of the random process itself is reduced to purely algebraic operations thereby offering and advantage over time description. Application of these frequency concepts to the problem of dynamic accuracy of linear servosystems is considered as an example of this method. M.P.G.

**N65-12372#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**CERTAIN NEW APPLICATIONS OF THE METHOD OF LOGARITHMIC FREQUENCY CHARACTERISTICS FOR INVESTIGATION OF AUTOMATIC CONTROL SYSTEMS**
N. T. Kuzovkov *In its* Autom. Control and Computer Tech. 25 Aug. 1964 p 114–150 refs (See N65-12367 03-34)

The application of the method of logarithmic frequency-response curves is described for the following problems: (1) calculation of the damping (degree of stability) of a linear automatic control system; (2) synthesis of correcting sections to give the system a prescribed damping; (3) construction in parameter spaces of boundaries of stability and lines of equal damping; (4) construction of the transient in a linear system for a unit step disturbance by a semilogarithmic, real, frequency-response curve; and (5) calculation of the accumulation of perturbations in linear systems with constant parameters. M.P.G.

**N65-12375#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**MAGNETIC AMPLIFIERS FOR SYSTEMS OF AUTOMATIC CONTROL**
M. A. Rozenblat *In its* Autom. Control and Computer Tech. 25 Aug. 1964 p 204–231 refs (See N65-12367 03-34)

A review of the use of magnetic amplifiers for automatic control systems is presented. Since selection of one or another design is determined by the purpose of the amplifier and the specific requirements of the application, the following types of amplifiers are discussed: (1) single-cycle magnetic amplifiers; (2) two-cycle magnetic amplifiers with output at carrier frequency; (3) two-cycle magnetic amplifiers with output on direct current; and (4) magnetic modulators (voltage regulators). Also discussed are the dynamic characteristics of magnetic amplifiers, and the increase of input impedance of magnetic amplifiers. M.P.G.

**N65-12429#** Oklahoma U., Norman.
**AN INVESTIGATION OF SOME SOLUTIONS TO THE SMOOTHING AND PREDICTION PROBLEM**
James Paul Bradley, Jr. (M.S. Thesis) Jul. 1964 56 p refs (AD-603481) OTS: $3.00

Available theoretical methods are evaluated in order to formulate a physically realizable smoothing and predicting filter. It was assumed that the mean-square error is a significant error measure, and that the signal and the noise were both stationary time series. A linear system was used as a self-imposed limitation. An examination of the conceived filter output showed fairly good smoothing and excellent signal detecting. G.G.

**N65-12485#** Michigan U., Ann Arbor. Electron Physics Lab.
**APPLIED RESEARCH IN MICROWAVE AND QUANTUM ELECTRONICS Interim Scientific Report No. 1, Mar. 1-Jul. 1, 1964**
J. E. Adair, J. E. Boers, G. I. Haddad, G. T. Konrad, R. J. Lomax et al Sep. 1964 60 p
(Contract AF 33(615)-1553)
(Rept.-06349-35; AD-449813)

An abbreviated form of the Kino short gun was investigated in a beam analyzer. Good agreement was observed between the theoretical and the experimental beam characteristics, and the system was found suitable as an injector for crossedfield electron devices. The harmonic spin coupling in a chromium-doped rutile was performed, and the population inversion at a signal frequency of 40 Gc with a pump frequency of 30 Gc was observed. A coupled-mode description is used, and closed-form solutions are found for several potential variations in the space-charge-wave propagation on electron beams in a nonuniform potential region. G.G.

**N65-12596*#** Martin Co., Baltimore, Md. RIAS
**ON THE EXISTENCE OF OPTIMAL STOCHASTIC CONTROLS**
Harold J. Kushner [1964] 25 p refs
(Contracts NASw-845; AF 49(638)-1206)
(NASA-CR-59752)

Proof is presented for several theorems stating, under their prescribed conditions, that if there exists one stochastic control that accomplishes a given task, then there is an optimal stochastic control. The systems of concern are governed by stochastic vector differential equations. G.G.

**N65-12746#** Michigan U., Ann Arbor. Electron Physics Lab.
**COUPLED-MODE DESCRIPTION OF SPACE-CHARGE-WAVE PROPAGATION ON ELECTRON BEAMS IN NONUNIFORM POTENTIAL REGIONS Technical Report No. 70**
G. I. Haddad and J. E. Adair Oct. 1964 57 p refs
(Contract AF 33(615)-1553)
(Rept.-06349-6-T; AD-451650)

Coupled-mode theory has been employed to obtain closed-form solutions for the space-charge-wave amplitudes on an electron beam drifting in a nonuniform potential region. Both accelerating and decelerating potential regions have been considered, and explicit expressions for the rf current and velocity modulations on the beam have been obtained. The results presented here are directly applicable to space-charge-wave amplifiers employing beam potential deceleration and to traveling-wave phototube light demodulators. A scheme for removing the noise from the slow space-charge wave by utilizing a nonuniform potential region is presented. Author

**N65-12783#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering
**AN EVALUATION OF SELECTED DESCRIBING FUNCTIONS OF CONTROL SYSTEM NONLINEARITIES**

Robert Richey Rankine, Jr. (M.S. Thesis) Jun. 1964 140 p refs
(GGC-EE-64-16; AD-603957) OTS: $5.00

A describing function is an amplitude-dependent generalized transfer function of a nonlinearity that can be used to represent the nonlinearity when its input is approximately sinusoidal. The simpler and more prominent or accurate describing-function generating schemes include the following: (1) the conventional; (2) the minimum average error; (3) the equivalent gain; (4) the new rms; and (5) the corrected conventional. An evaluation of these various schemes, based on the accuracy with which the describing functions they produce can predict the amplitude and frequency of self-sustained oscillations in a nonlinear system, reveals that the corrected conventional describing functions are more accurate for single-valued nonlinearities. Author

N65-12972# New York U., N.Y. Lab. for Electroscience Research
**ANALYSIS OF DRIFT TRANSISTOR CURRENT GAIN WITH APPLICATION TO DISTRIBUTED RC NETWORKS Twelfth Scientific Report**
John J. Kelly, Jr. Jul. 1964 99 p refs
(Contract AF 19(628)-379)
(AFCRL-64-766; TR-400-98; AD-608326)

The common-emitter short-circuit current gain of the intrinsic graded base transistor is analyzed using the factor theorem of Weierstrass. The factor theorem permits the description of the gain function in terms of its low frequency value, i.e., the dc current gain and the poles and zeros of the function. The primary purpose of the research is to show the applicability of the factor theorem to the analysis of network functions typical of those encountered in integrated circuit structures. For this purpose the gain functions of drift transistors are analyzed in detail, and their similarities to passive distributed RC network functions are noted. The second purpose is to develop techniques for determining the steady-state and transient response of distributed active (or passive) networks in a simple manner without resorting to computers. For the calculation of these quantities, the effective dominant pole and the excess phase factor are derived directly in a systematic manner from the product expansion form. Author

N65-13042# Army Signal Research and Development Agency and Lab., Fort Monmouth, N.J. Electron Tubes Div.
**A GRAPHICAL PROCEDURE FOR RELATING THE PERVEANCE AND POWER CHARACTERISTICS OF MICROWAVE TUBES**
G. E. Wurthmann, P. Fischer, and P. Richmond Aug. 1964 14 p
(TR-2506; AD-608297)

This report presents a convenient, graphical method of determining important, interrelated microwave tube parameters such as power output, efficiency, perveance, current, and voltage. Pertinent tube characteristics are plotted on three, overlapping, logarithm graphs, which offer a rapid, straightforward means of finding the desired parameters over a wide range of current, voltage, and power. The operational procedure for using the graphs in solving for the variables of interest is demonstrated by three examples. Author

N65-13132# California U., Berkeley. Electronics Research Lab.
**CONSOLIDATED QUARTERLY PROGRESS REPORT, MAY 16–AUGUST 15, 1964**
D. J. Angelakos [1964] 139 p refs
(Grants NsG-354; AF-AFOSR-139-64; Contracts DA-36-039-AMC-02164(E); Nonr-222(53) et al)
(Rept.-14; AD-608748)

Progress is reported in the following research areas: (1) bioelectronics—dielectric constant changes in enzyme reactions, protonic semiconductors, and neurodynamics; (2) circuits—network synthesis, transfer function of multiloop feedback amplifier, sensitivity functions, and broadband matching theory; (3) electron streams—instabilities, magnetron characteristics, and crossed-field amplifier design; (4) plasmas—rotating plasmas, magnetic instabilities, and synchrotron radiation from hot electron plasma; (5) radiation and propagation—anisotropic obstacles in waveguides, log-periodic antennas, and spiral antennas; (6) solid state electronics—silicon junctions, electron-hole plasmas, photopiezoelectric effects, scanning electron microscopy, thin film devices, and integrated circuits; (7) systems—optimal control problems, stochastic processes. D.S.G.

N65-13159# Texas Instruments, Inc., Dallas. Semiconductor-Components Div.
**OPTOELECTRONIC FUNCTIONAL ELECTRONIC BLOCKS Interim Engineering Report, 1 May–31 Jul. 1964**
J. R. Biard 27 Aug. 1964 70 p refs
(Contract AF 33(657)-11552)
(IER-03-64-56; AD-604888)

The combination of the isolation feature of optical coupling with existing silicon integrated-circuit technology has resulted in the fabrication of the first optoelectronic pulse amplifiers. The characteristics and performance of these amplifiers are reported. To implement the optoelectronic functional electronic blocks concept, the following semiconductor technology and measurement investigations are being conducted: (1) evaluation of several high-index glasses as optical coupling media; (2) measurement of transient rise time of light output from GaAs infrared sources; (3) characterization of GaAsP light emitters; (4) development of an improved infrared-spectrometer detection system; (5) development of a new planar etching technique for the A face of 111 oriented GaAs; and (6) characterization of GaAs guard-ring diodes. M.P.G.

N65-13179# College of Aeronautics, Cranfield (Gt. Brit.)
**A CORRELATOR BASED ON DELTA MODULATION TECHNIQUES**
H. B. Gatland and R. J. A. Paul Aug. 1964 23 p ref
(CoA-E&C-3)

The correlator described in this paper is a specific application of a general method of hybrid computation based on delta modulation techniques, described in a previous paper. A description is given of the basic elements of the system, and some details of operating performance are included. Experimental results are also described to illustrate its application to the analysis of stochastic signals. Author

N65-13311# Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering
**APPLICATION OF LIMIT-CYCLE AND PARAMETER-PERTURBATION ADAPTIVE TECHNIQUES TO CONTROL OF THE FLEXIBLE SUPERSONIC TRANSPORT**
Nicholas C. Belmonte and Rance S. Edmunds (M.S. Thesis) May 1964 259 p refs
(GGC/EE/64-3; AD-604066) OTS: $7.00

Two distinct self-adaptive concepts are explored to determine their value when applied to the supersonic transport flight control problem. Two normal-acceleration longitudinal

stability-augmentation systems are designed, analog-simulated, and evaluated for a vehicle having characteristics closely approximating those of the current supersonic transport designs. The first system treated employs the relatively familiar light-cycle concept, and operates on a high-gain principle. The second system makes use of the less familiar parameter-perturbation concept and operates on a minimum, mean-square-error principle. Author

**N65-13341** Naval Applied Science Lab., Brooklyn, N.Y.
**LIMITING SYNCHRO LOADS IN 60 CYCLE CONTROL, TORQUE AND MIXED SYSTEMS FOR MIL-S-20708A SYNCHROS, PART 2 Final Report**
C. J. Dipietro 17 Jul. 1964 33 p
(AD-607176) OTS: $2.00

Limiting synchro loads in 60 cycle systems, load current for 10% voltage regulation, and optimum capacities were determined for synchros. Limiting loads were determined from measured synchro parameters, applied to formulas developed by the Laboratory. Synchro loads that may be carried in control, torque, and mixed control–torque systems are tabulated. Load currents and optimum values for synchro capacitors, two of the parameters used to determine synchro loads, are also tabulated. Author

# 11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

**N65-12336*#** Hayes International Corp., Birmingham, Ala. Missile and Space Support Div.
**APOLLO LOGISTICS SUPPORT SYSTEMS MOLAB STUDIES REPORT: T.V. SYSTEMS STUDIES FOR A LUNAR MOBILE LABORATORY**
J. C. Mc Bride Huntsville, Ala., NASA. Marshall Space Flight Center, Oct. 1964 88 p refs
(Contract NAS8-5307)
(NASA-CR-61017) OTS Prices: HC $3.00/MF $0.75

In order to determine the requirements of the optics and television pickup device to be used aboard the Lunar Mobile Laboratory, the available surface brightness was considered. This brightness is a function of the illumination level (either direct sunlight or earthshine), the albedo of the lunar surface, and the photometric function relating the brightness to angles of incidence and emittance and the spherical angle between them. Also discussed were the following: optics and scanning requirements—resolution of objects, lens photometry, aperture and shutter control; bandwidth considerations—frame rate, resolution ratio, stereoptics, range finding; artificial illumination; and the up-link television subsystem. D.S.G.

**N65-12337*#** Northrop Space Labs., Huntsville, Ala.
**APOLLO LOGISTICS SUPPORT SYSTEMS MOLAB STUDIES: TASK REPORT ON MISSION COMMAND AND CONTROL Technical Report, 1 Jul. 1964–1 Sep. 1964**
Arch W. Meagher and Robert J. Bonham Huntsville, Ala., NASA Marshall Space Flight Center, Oct. 1964 61 p refs
(Contract NAS8-11096)
(NASA-CR-61020) OTS Prices: HC $3.00/MF $0.75

The stability of the MOLAB VII concept on sloping surfaces, and the effect of the center-of-gravity height on limiting the stability under various conditions of surface, speed, and steering angles were investigated. It was found that the major factors contributing to the instability are the reduced lunar gravity, short wheel base, and high center of gravity. Although the lunar gravity is fixed, its effects can be compensated to some degree by the use of an active suspension system, incorporating controlled dampers and a vehicle-leveling device. The location of the center of gravity is very critical; the present height of approximately 5 feet is too great for good stability. The active suspension system would lessen the effect, but it does not offer a total solution to the problem. The general equations of motion for an articulated MOLAB were derived and are presented in the second part of this report. D.S.G.

**N65-12380#** National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.
**RESEARCH ON LINEAR CROSSED-FIELD STEADY-FLOW D.C. PLASMA ACCELERATORS AT LANGLEY RESEARCH CENTER, NASA**
G. P. Wood, A. F. Carter, A. P. Sabol, D. R. Mc Farland, and W. R. Weaver *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 1–45 refs (See N65-12379 03-34)

Results obtained from research on linear crossed-field plasma accelerators and research in progress with 1-$cm^2$ and small expanding accelerators are described. The solutions to problems incurred with the arc heater and seeding apparatus for a 2.5-$cm^2$ accelerator are given, and operational problems due to large Hall potentials and to erosion are discussed. The theory is improved by deriving the equations that describe the flow without making the assumptions that are usually made concerning the specific heats, and that are not valid at high temperatures. Time-of-flight velocity measurements constitute the principal diagnostic method. The 2.5-$cm^2$ accelerator works well; it accelerates nitrogen from 2000 to 6000 m/sec with an exit density corresponding to an altitude of 45 km. Author

**N65-12387#** Thermal Dynamics Corp., Lebanon, N.H.
**ARC GAS HEATERS—PRESENT AND FUTURE**
J. A. Browning and J. W. Poole *In* AGARD ARC Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 323–351 refs (See N65-12379 03-34)

Numerous arc-heater designs have been investigated. Of these, the one seeming to offer the most promise for the major scale-up required is the in-line configuration that provides for the simultaneous passage of both the arc column and a constricting gas flow through an elongated tube. Such a design brings a large portion of the gas into direct contact with the arc. In a continuing effort to increase the exhaust enthalpy of arc gas heaters, new techniques for increasing the arc-constricting action of a given gas mass flow have been developed. New electrode concepts, suitable for operation with compressed air, have been made practical. These new developments are expected to play an important role in the effort to scale net power levels to the 80-MW range, while maintaining the arc at pressures as high as 350 atm with enthalpies over 3000 Btu/lb. Author

N65-12388# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**SUMMARY OF SOME OF THE ARC-HEATED HYPERSONIC WIND-TUNNEL DEVELOPMENT EFFORT UNDERWAY AT THE LANGLEY RESEARCH CENTER**

W. B. Boatright, R. B. Stewart, D. I. Sebacher, and M. A. Wallio *IN* AGARD ARC Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 353–377 refs (See N65-12379 03-34)

Measurements of the flow properties in the test section of a Mach 12, arc-heated wind tunnel, using an electron-beam technique, show that the rotational temperature is near equilibrium and that the vibrational temperature is out of equilibrium. The vibrational temperature is farther from equilibrium when copper electrodes are used in the heater than when silver electrodes are used. A hypersonic arc-heated tunnel with a 4-foot-diameter test section and a 10-megawatt direct-current power supply is described, and results of initial tests are presented. An arc-heater-accelerator device that uses a magnetic field to rotate the arc, which in turn accelerates the test air, is described. The air velocity as deduced in this device by two separate techniques indicates that, at airmass flow rates approaching 0.02 lb/sec, supersonic flow has been achieved when exhausting to atmospheric pressure even though the pressure in the heater is much lower than that ordinarily required to generate a sonic flow. Author

N65-12389# ARO, Inc., Arnold Air Force Station, Tenn.

**IRREVERSIBLE FLOW IN RESERVOIR AND THROAT SECTIONS OF WIND TUNNELS WITH CONSTRICTED-ARC HEATERS**

J. Leith Potter, George D. Arney, Jr., William H. Carden, and Max Kinslow *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 379–412 refs (See N65-12379 03-34)
(Contract AF 40(600)-1000)

Characteristics of flows in reservoir and throat sections of arc-heated wind tunnels are discussed under four main headings: flow uniformity, thermochemical equilibrium, heat loss, and flow steadiness. The influence of typical variations in structural design and flow properties is shown by presentation of experimental data and related theoretical analysis. The principal variables were enthalpy, pressure, reservoir size, nozzle throat diameter, mass flux, and, to a lesser extent, gas medium. Quantitative values of these variables correspond to operating conditions of a continuous-type, arc-heated, low-density, hypersonic wind tunnel. When settling chambers were used in the experiments reported, uniformity of flow entering the nozzle throat appeared to be excellent. The states of thermochemical equilibrium depended largely on reservoir pressure and length, nonequilibrium being the rule when pressure was below approximately 1 atm. Heat loss is shown to be a penalty when settling chambers are used. An empirical equation is included to summarize the effects of small changes in the major variables for the cases examined. Flow steadiness in the reservoir of a wind tunnel was measured, and a limited range of variables were investigated. The relation between fluctuations in current, voltage, reservoir pressure, and plasma luminosity is described. Fluctuations in reservoir pressure on the order of from 5 to 10 percent of the mean value were found at particular frequencies up to the limit of the equipment that was approximately 20 kc, with peaks existing in the 0.3 to 0.5, 1.6 to 1.8, and 6 to 16 kc/sec regions. Heat-transfer rate to a fine-wire anemometer in the test section where Mach number was 10 showed slightly less than ±3 percent fluctuation about the average value. Author

N65-12390# Naval Ordnance Lab., White Oak, Md.

**THREE-PHASE A.C. ARC HEATER STUDIES AT THE U.S. NAVAL ORDNANCE LABORATORY**

E. M. Winkler, R. E. Lee, R. L. Humphrey, and L. J. Milner *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 413–449 refs (See N65-12379 03-34)

Studies presented by both experimental and analytical approaches have attempted to provide some answers to the general behavior of ac arcs, the design of the electrodes, and the energy balance of the system. The studies have developed the electrical requirements for high-pressure operation, have led to design improvements, and have revealed the severity of convection and radiation losses. The conclusions reached from tests with a first heater have been utilized to design two other configurations. Preliminary data on the two new arc heaters are presented. Author

N65-12392# Electro-Optical Systems, Inc., Pasadena, Calif.

**UTILIZATION OF ELECTROMAGNETIC FORCES IN A COAXIAL ARC FOR HIGH VELOCITY AND ENTHALPY REENTRY SIMULATION**

Robert L. Harder and Gordon L. Cann *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 487–513 refs (See N65-12379 03-34)
(Contracts NAS3-3568; AF 33(657)-10789)

This paper shows how Lorentz ($J \times B$) forces will affect the design and operation of axially symmetric direct current arc heaters. Both the radial and the axial forces are discussed to show the effect they will have on velocities and losses in the heater. Mathematical expressions are given for some simple cases including pressure distribution in an arc column and total momentum increment in an expanding arc. Using the analysis, an accelerator configuration and a model of the electromagnetic interaction with the plasma were postulated. A point cathode is placed inside a ring anode. The electrodes are placed inside a short solenoidal magnet. Plasma is generated near the surface of the electrodes. This plasma flows downstream in an inner core and an outer cylinder, separated by a nonconducting layer. Far downstream, the two layers join together. The electric current path from anode to cathode is via this long loop. The external solenoidal magnet produces a diverging magnetic field in the region. The axial current in the outer cylinder and the applied radial magnetic field cause tangential Hall currents. These Hall currents in the jet interact with the radial magnetic field to produce the thrust. The reaction of this thrust is in the magnet. The Hall currents induce a magnetic field that tends to let the accelerated plasma flow unimpeded out of the applied magnetic field. Several accelerator models were built and tested. Author

N65-12401# Michigan U., Ann Arbor.

**FUNDAMENTAL CONSIDERATIONS IN ARC HEATER DESIGN**

Richard L. Phillips *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 797–843 refs (See N65-12393 03-34)

Certain design criteria fundamental to the successful operation of an ac arc-heater facility are discussed in some detail. An approximate model of a cooled metallic electrode, which is being heated by a moving arc, is analyzed, indicating which combination of parameters affects electrode lifetime. The behavior of a three-phase inductive circuit containing arcs is studied, assuming a temporal square-wave arc-voltage variation. It is shown that predictions of power factor, maximum useful power, rms current, etc., can be made if only the ratio

of the arc voltage to the peak line voltage is known. The results of a study of the detailed energy-transfer processes occurring within the positive column of an ac arc are presented and discussed. Excellent agreement between analytically derived and measured electric-field waveforms is shown. Author

**N65-12403#** Deutsche Versuchsanstalt für Luft- und Raumfahrt, Stuttgart (W. Germany). Institut für Plasmadynamik
**ARC HEATERS PRODUCING FLAT TEMPERATURE DISTRIBUTIONS**
Th. Peters *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 883–902 refs (See N65-12393 03-34)

Arc heaters with dc current operation produce a jet with a nonuniform temperature profile. To obtain a more uniform temperature profile, a plenum chamber is usually needed. The disadvantage of this method is that more than 50% of the arc power is lost in the cooling water of the plenum chamber. This paper describes arc experiments employing an ac magnetic-field configuration with the object of obtaining a flat temperature distribution in the jet. Applying an ac magnetic field produces a high degree of irregular turbulent motion inside the chamber, resulting in a flat temperature distribution of the jet as is desirable for wind-tunnel operations. Author

**N65-12418*#** General Electric Co., Cincinnati, Ohio. Advanced Engine Technology Dept.
**BROMINE TRIFLUORIDE METHOD FOR OXYGEN IN LIQUID ALKALI METALS Third Quarterly Report, Jul. 1–Sep. 30 1964**
Hyman Kirtchik and Sigmond L. Culp 18 Oct. 1964 26 p
(Contract NASw-882)
(NASA-CR-59640; DM-64-411) OTS Prices: HC $2.00/MF $0.50

The modified NASA extruder and other apparatus changes are described. The exit double-trap system was modified to a coil type, completely submersible in pentane slush. This allowed for better temperature control, and resulted in acceptable blanks of 5 to 20 micrograms of oxygen per hour, with $BrF_3$ in the reaction cell. Complete recoveries of $KBrO_3$ spikes were only obtained under certain specific conditions, which apparently limited the solubility of oxygen in $BrF_3$. Author

**N65-12428#** Mound Lab., Miamisburg, Ohio.
**SHOCK TUBES: A BIBLIOGRAPHY (SUPPLEMENT I)**
Arnold M. Melnick 17 Dec. 1964 12 p refs
(Contract AT(33-1)-GEN-53)
(MLM-1189(Supp))

**N65-12442*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**PRELIMINARY EXPERIMENTS WITH A VELOCITY-SELECTED ATOMIC-BEAM APPARATUS**
Eugene J. Manista and John W. Sheldon Washington, NASA, Dec. 1964 33 p refs
(NASA-TN-D-2557) OTS Prices: HC $2.00/MF $0.50

An atomic-beam apparatus was designed and constructed to study velocity-dependent total-collision cross sections at thermal energies. The beam may be velocity selected over the range of $7 \times 10^3$ to $1 \times 10^5$ centimeters per second, to provide an intense, monoenergetic (velocity spread at half-maximum calculated ≈ 5 percent) beam of atoms. The effect of atomic scattering by a cloud of beam atoms near the source slit is investigated. Absolute total-collision cross sections for the cesium–nitrogen ($Cs-N_2$) and cesium–argon (Cs-Ar) interactions were measured by total-beam attenuations with an angular resolution of 3.2 minutes. The cesium-beam temperature was 447° K, and the scattering-gas temperature was 293° K. A "hard-sphere" cross section of $710 \times 10^{-16}$ square centimeter was measured for the $Cs-N_2$ interaction, and a cross section of $700 \times 10^{-16}$ square centimeter was measured for the Cs-Ar interaction. The absolute values of the cross sections are accurate to ±10 percent. Author

**N65-12532#** Atomic Energy Commission, New York, N.Y. Health and Safety Lab.
**A PROCEDURE TO DETERMINE THE RELATIVE EXTENT OF REACTOR FISSION PRODUCT RELEASES UNDER VARIOUS METEOROLOGICAL CONDITIONS**
Stephen J. Lanes Jul. 1964 54 p refs
(HASL-148) OTS: $3.00

Several versions of Sutton's equations expressing the atmospheric concentrations, doses, etc. due to a fission-product release have been programed for solution by an IBM-1620 computer, as an aid in evaluating the effects of postulated reactor accidents. In addition, each of these equations has been solved over a wide range of meteorological parameters and the results graphed, providing an illustration of the effects of changes in one parameter or a combination of them on the solutions. A procedure for the application of these programs and graphs to the review and evaluation of reactor safety problems is presented. Author

**N65-12553#** Arnold Engineering Development Center, Arnold Air Force Station, Tenn.
**NON-CONTAMINATING COMBUSTION AIR HEATER FOR WIND TUNNELS**
Robert O. Dietz, Jr. Nov. 1964 26 p refs
(AEDC-TDR-64-185; AD-451305)

An analysis of a wind-tunnel combustion air heater that will provide uncontaminated air at temperatures above 4000° R is presented. Concept of the heater involves combustion of metals that yield oxides having melting temperatures above 4000° R. Heat is transferred to air from liquid metal-oxide particles formed in a metal–oxygen combustor. The oxide particles solidify during the heat-transfer process and are separated from the air by centrifugal forces. A portion of the heated air is bled from the periphery of the separator to carry the oxide particles out of the wind tunnel air supply system. Thermodynamic analyses of the heater are discussed, and they show that combustion of 0.077 lb of aluminum per pound of air will provide a wind-tunnel air-supply temperature of 4100° R. Author

**N65-12558#** Aerospace Corp., El Segundo, Calif. Electronics Div.
**ELECTRONICS RESEARCH PROGRAM: SATELLITE ATTITUDE CONTROL SYSTEM EXPERIMENTS Semiannual Technical Report, 1 Jan.–30 Jun. 1964**
D. J. Griep 25 Sep. 1964 83 p refs
(Contract AF 04(695)-269)
(SSD-TDR-64-181; TDR-269(4250-32)-3; AD-451422)

The degradation of the pulsed performance of low-thrust, cold-gas, jet reaction systems is shown; also, the experimental data are compared with analytical results. Preliminary experimental results using anhydrous ammonia gas as a propellant are included. The experimentation conducted on a single-axis attitude-control system utilizing a fluid flywheel is presented, along with an analysis of this system. The preliminary results of an analysis of the single-axis vehicle-simulator

incremental follow-up servo are given. In addition, a specific-impulse pneumatic test facility and a manned tracking target-symbol generator are described. Author

**N65-12574#** Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
**ROCKET IMPACT PREDICTION EQUIPMENT AT WHITE SANDS MISSILE RANGE**
Roy I. Glass, Jr. Nov. 1964 26 p refs
(ERDA-211; AD-451948)

An impact prediction system for unguided rockets was developed at White Sands Missile Range. The impact predictions are made relative to the wind effects on the ballistic trajectory. An analog computer is described, that calculates the impact variations, and a digital system is presented, that calculates launcher angles for the rocket. Author

**N65-12586#** Battelle Memorial Inst., Columbus, Ohio. Radiation Effects Information Center
**RADIATION-EFFECTS EXPERIMENTAL PROCEDURES**
D. C. Jones, B. P. Fairand, H. T. Gruber, and A. E. Mace
31 Aug. 1964 60 p refs
(Contract AF 33(615)-1124)
(REIC-35; AD-447977)

This report presents information for planning, preparing, conducting, analyzing, and reporting a radiation-effects experiment. The information is directed toward the engineering-type experiment rather than the research type. Author

**N65-12590#** Naval Ordnance Lab., White Oak, Md.
**NOL'S MACH 17 NITROGEN WIND TUNNEL**
E. L. Harris, J. W. Carner, L. Pasiuk, and C. T. Wint Dec. 1964 54 p refs *Its* Aeroballistics Res. Rept.-229
(NOLTR-64-128; AD-451503)

A continuous hypersonic wind tunnel, which was put into operation at the U.S. Naval Ordnance Laboratory in 1963, is described. The tunnel uses nitrogen heated to 5000° R by a graphite-resistance heater. The Mach-number capability is from 12 to 18, with test-section Reynolds numbers from $2.6 \times 10^4$ to $7 \times 10^5$ per foot. Operations were restricted to the neighborhood of Mach 17.5 and $10^5$ per foot in Reynolds number. The design and operation of the wind tunnel and some of the initial experimental results are presented. Author

**N65-12607*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**FACILITY DESCRIPTION: GODDARD ANTENNA TEST RANGE**
Paul A. Lantz Oct. 1964 42 p refs
(NASA-TM-X-55107; X-525-64-223) OTS Prices: HC $2.00/MF $0.50

This report contains descriptions of the horizontal and vertical ranges, the house, and the receiving and transmitting towers. The capabilities of the horizontal and vertical ranges are expressed by considerations of the phase and amplitude variations. A radio-frequency-interference survey lists all those frequencies at which a signal was detected. G.G.

**N65-12632#** Astrosystems International, Inc., Fairfield, N.J.
**RESEARCH AND DEVELOPMENT PROGRAM TO DEMONSTRATE THE FEASIBILITY OF A HIGH INTENSITY SOUND GENERATOR Final Report, Jan. 1963–Feb. 1964**
Raymond E. Wiech, Jr., Harry L. Preston, Maurice Levy, and Allen Schwalb 3 Jun. 1964 159 p refs
(ARPA SD-169)
(TR-63002F; AD-450184)

A two-phase program was conducted to demonstrate the feasibility of using an intermittent gaseous detonation device to generate high-intensity sound. Results were as follows: (1) Operation of the single-tube unit produced peak sound pressures of 165 dB at the tube outlet and an average value of 77 dB at a distance of 1000 feet. (2) Corresponding levels for the 8-tube array were 184-dB peak at the outlet and 91-dB average at 1000 feet. During brief and intermittent testing intervals of the 64-tube unit, instantaneous peak values of 195 dB were measured at the outlet and peak values as high as 119 dB were noted at 1000 feet. Author

**N65-12652#** Deutsche Versuchsanstalt für Luft- und Raumfahrt, Aachen (W. Germany). Inst. für Angewandte Gasdynamik
**THE HORIZONTAL TEST SECTION OF THE SUPERSONIC WIND TUNNEL AT AACHEN [DIE HORIZONTALE MESSSTRECKE DES AACHENER UBERSCHALLWINDKANALS]**
Alfred Heyser Oct. 1964 58 p refs In GERMAN; ENGLISH summary
(DLR-FB-64-22; DVL-349) Available from ZLDI, Munich: DM 20

The cross-section of the horizontal supersonic test section of the blow-down wind tunnel at Aachen is $30 \times 30$ cm$^2$; it has been designed for a maximum Mach-number of 7 at maximum static pressure of 50 ata. This report deals with construction and measurement results for the function of this test section. Author

**N65-12729*#** Dunlap and Associates, Inc., Darien, Conn.
**RESEARCH ON MAN-MACHINE RELATIONSHIPS IN PRELAUNCH CHECKOUT OF ADVANCED SPACE VEHICLES Quarterly Progress Report No. 1, 1 Jun.–1 Sep. 1964**
14 Sep. 1964 70 p refs *Its* Rept.-510-QR-1
(Contract NASw-954)
(NASA-CR-59699; DRD-64-122) OTS Prices: HC $3.00/MF $0.75

Initial work is reported on investigating the factors affecting the development of confidence during checkout, on optimization of astronaut participation in prelaunch test and checkout activities, on a study of man–computer roles in prelaunch failure diagnosis, on an investigation of possible techniques of failure anticipation, on future man–machine roles in semi-automated test planning and programing, and on an investigation of apparent movement phenomena on CRT display units, such as those planned for use in the Apollo prelaunch checkout. D.E.W.

**N65-12744#** Army Missile Command, Huntsville, Ala. Electromagnetics Lab.
**STATUS OF THE EVALUATION OF THE MISSILE SIGNATURE AND ELECTROMAGNETIC EMISSION RESEARCH FACILITY (84-FOOT MADKIN MOUNTAIN ANTENNA REDSTONE ARSENAL, ALABAMA)**
Harold B. Buie and Thomas A. Barley 26 Oct. 1964 301 p refs
(RE-TR-64-21; AD-450978)

An evaluation of the Madkin mountain 84-ft parabolic antenna and its ancilliary equipment is progressing. Mechanical, electrical, and dynamic characteristics of the antenna are being

investigated as the basis for the design of future experiments and research programs using this facility. After a general description and theory of operation of the facility, the following subsystems are discussed: servo equipment, receiving equipment and radiometer, S-band modification kit, coordinate converter, and the electromagnetic environment of the facility. Calibration, pattern, and range data are appended. M.P.G.

**N65-12784#** Pacific Missile Range, Point Mugu, Calif.
**A BASIC APPROACH TO THE SELECTION OF RANGE SAFETY PROGRAMS**
J. J. Bellaschi, L. A. Leake, and J. M. Stroud 22 Oct. 1964 8 p refs
(PMR-TM-64-7; AD-449943)

Decision-making rules must be formulated, and decisions relating to the values of life and expected cost of same must be made before a range safety program is adopted. Economic cost categories, both tangible and intangible, must be considered. Total cost must be measured, including its four cost elements—range safety program costs, range user costs, casualty and property damage costs, and intangible losses from accidents. The level of attainment of accident prevention is an additional consideration. A comparison of the cost and effectiveness levels presents a methodology for selecting from among possible range safety programs. This methodology considers total cost as the sensitive factor in the adoption of a final policy. Author

**N65-12816*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**GODDARD SUMMER WORKSHOP PROGRAM IN MEASUREMENT AND SIMULATION OF THE SPACE ENVIRONMENT Final Report, Jun. 18–Sep. 18, 1963**
[1963] 300 p refs
(NASA-TM-X-55015; X-320-63-264) OTS Prices: HC $6.00/MF $1.50

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**N65-12834#** Sandia Corp., Albuquerque, N. Mex.
**OPERATION CHARACTERISTICS OF THE SANDIA 120-KW PLASMA ARC TUNNEL**
P. T. Lubeck Nov. 1964 43 p refs Sponsored by AEC
(SC-RR-64-1701)

Experimental results are presented from three of the most common modes of operation of the 120-kW plasma arc tunnel—argon gas with a straight anode, argon gas with a stepped anode, and nitrogen gas with a stepped anode. The experimental results presented are specific energy of the jet, exit pitot pressure in the jet, relative efficiency of the tunnel, and input power to the tunnel. Author

**N65-12850#** Aberdeen Proving Ground, Md. Ballistic Research Labs.
**BLAST PATTERNS IN COMPLEX TUNNEL MODELS**
George D. Teel Apr. 1964 52 p
(BRL-TN-1533; AD-609289)

The detonation-driven shock tube was utilized to expose four complex tunnel models to high-pressure blast waves. The models were exposed to shock pressures of 200, 500, and 800 psi. The data obtained from the shock-tube tests were

reduced, plotted, and extrapolated to give expected values for the models when exposed to a 1500-psi shock wave from a 10-megaton nuclear weapon. Author

**N65-12855#** Politecnico di Torino (Italy). Laboratorio di Meccanica Applicata

**EXPERIMENTAL RESEARCH WITH A SHOCK TUBE OF THE "CENTRO STUDI SULLA DINAMICA DEI FLUID"**

**Scientific Report No. 1**

Ario Romiti Libreria Editrice Univ. Levrotto & Bella, Jun. 1964 16 p refs Submitted for Publication *Its* Tech. Note No. 25

(Grant AF-EOAR-63-98)

(AFOSR-64-1876; AD-449981)

The iron shock tube has a 50-mm inside diameter; the lengths of the high and low pressure chambers are 1 and 4 meters, respectively. Described are the methods and apparatus used in making shock-speed measurements, wall-temperature and heat-flux measurements on models, pressure measurements, measurements with Langmuir probes, and electrically insulated probe research. R.L.K.

**N65-12863#** Weapons Research Establishment (Australia).

**SOME EFFECTS OF TEMPERATURE VARIATIONS ON THE 80 INCH DELFT LENS**

A. J. Fisher and N. S. Bromilow Sep. 1964 22 p refs

(WRE-TN-ISD-53)

The use of a sun shield considerably reduces the temperatures and temperature gradients that occur within the lens; a very efficient external surface finish for a sun shield or lens body is glossy white titanium-dioxide paint. The laboratory tests show that a large inward focal shift takes place when the lens is subjected to a rapidly rising temperature. After reaching equilibrium at a higher temperature, the focal plane partially recovers toward its original position. The reasons for this effect and its influence on lens performance are discussed. Author

**N65-12881#** Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati

**MAGNETIC MEASUREMENTS ON MODELS OF MAGNETS AND QUADRUPOLES FOR ADONE [LE MISURE MAGNETICHE SUI MODELLI DEI MAGNETI E DEI QUADRUPOLI DI ADONE]**

M. Placidi 20 Jul. 1964 74 p refs In ITALIAN *Its* Nota Interna No. 250

(LNF-64/34)

Characteristics of scale models of the magnet and quadrupoles of Adone, the high energy synchrotron at Frascati, and the methods and instrumentation for measurements are given. P.F.E.

**N65-12883#** Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati

**MEAN LEVELS OF RADIATION AROUND THE STORAGE RING OF A LINEAR ACCELERATOR [LIVELLI MEDI DI RADIAZIONE INTORNO ALL'ACCELERATORE LINEARE E ALL'ANELLO DI ACCUMULAZIONE]**

M. Bernardini 27 Oct. 1964 27 p refs In ITALIAN *Its* Nota Interna No. 263

(LNF-64/54)

Calculations of the radiation levels around the storage ring of the linear accelerator at Frascati are given. The results of the calculations and the design of the accelerator are presented. Also presented are calculations of the radioactivity in the accelerator tunnel. Trans. by P.F.E.

**N65-12888#** Aberdeen Proving Ground, Md. Human Engineering Labs.

**DEVELOPMENT OF A ROCKET-BLAST-SIMULATOR: DESIGN AND TEST**

Edsel A. Spellman Feb. 1964 72 p

(TM-4-64; AD-449417)

The engineering design, development, and testing of a facility used to simulate the effects of rocket blast upon military personnel are described. The most formidable problems encountered were the necessity of achieving a high-order reliability to assure safety; and the requirement for a total pressure rise within five milliseconds to achieve high blast impulse. Both of these problems were resolved through the design of a novel side-mounted valve actuated by a sudden pressure differential resulting from the bursting of a pressurized diaphragm. Author

**N65-13006#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**LINEAR ION ACCELERATORS**

D. V. Karetnikov, I. N. Slivkov, V. A. Teplyakov, A. P. Fedotov, and B. K. Shembel' 11 Aug. 1964 244 p refs Transl. into ENGLISH of the book "Lineynyye Uskoriteli Onov" Moscow, Gos. Izd. Lit. v Oblasti at. Nauki i Tekhn., 1962 p 1–208

(FTD-MT-63-282; AD-608202)

A systematized account of the main problems of the theory, design, and construction of linear ion accelerators is presented. Subjects discussed include the principles of operation, the theory of the motion of particles in an accelerator, focusing in a linear accelerator, high frequency accelerating systems, injection devices, the electrical strength of vacuum insulation and spurious loads in accelerators, problems of high frequency feed, and the construction of linear accelerators. D.E.W.

**N65-13076#** David Taylor Model Basin, Washington, D.C. Hydromechanics Lab.

**HYDROMECHANICS CAVITATION RESEARCH FACILITIES AND TECHNIQUES IN USE AT THE DAVID TAYLOR MODEL BASIN**

W. F. Brownell and M. L. Miller Oct. 1964 28 p refs Presented at the Fluids Engr. Div. Conf., ASME, Philadelphia, 18–20 May 1964

(DTMB-1856; AD-607773)

Facilities for testing scale models of ship propellers, foils, and submerged bodies range from the variable-pressure water tunnels to the high-speed basin with its associated towing carriages and propeller dynamometers. Subcavitating, supercavitating, and ventilated model tests are discussed. Author

**N65-13108#** ARO, Inc., Arnold Air Force Station, Tenn. Propulsion Wind Tunnel Facility

**TRANSONIC BLOCKAGE INVESTIGATION OF A PROPOSED DYNAMIC WIND TUNNEL MOUNT WITH AN AIRPLANE-TYPE MODEL INSTALLED (MODEL FLY PROGRAM, USAF)**

R. I. Lowndes Arnold Eng. Develop. Center, Oct. 1964 22 p refs

(Contract AF 40(600)-1000)

(AEDC-TDR-64-218; AD-449725)

An aerodynamic blockage investigation was conducted on a 1/16-scale model of a dynamic wind-tunnel mount with an airplane-type model attached to the sting support. This investigation was performed from Mach 0.6 to 1.30. The results are presented in terms of test-section wall suction required to

establish Mach number. A maximum effective blockage of 5.2% occurred at Mach 1.20 for one unsymmetrical model configuration. Author

**N65-13112#** Southern Research Inst., Birmingham, Ala. Mechanical Engineering Div.
**GAS-BEARING FACILITIES FOR DETERMINING AXIAL STRESS-STRAIN AND LATERAL STRAIN OF BRITTLE MATERIALS TO 5500° F**
C. D. Pears and F. J. Digesu [1964] 45 p Presented at the Ann. Meeting of ASTM, Chicago, Jun. 1964

Facilities have been developed for the determination of axial stress–strain and lateral strain of brittle materials to 5500° F. This paper describes those facilities and presents performance data that confirm the improved capabilities. Gas-bearings were developed that permit the application of uniaxial loads to specimens in tension and compression, and specimens with shear gage sections. Also, optical strain analyzers were developed that follow the axial and lateral strains with an uncertainty of no more than 20 μin., thus permitting precise measures of modulus of a ceramic such as alumina or beryllia. Both graphite and tungsten furnaces were developed that can be used to heat the specimen radiantly to temperatures in excess of 5000° F. Author

**N65-13119#** Weapons Research Establishment (Australia).
**FACTORS INFLUENCING THE OPTICAL PERFORMANCE OF RANGE INSTRUMENTATION**
C. B. Rogers Jul. 1964 29 p refs
(WRE-ISD-13)

An analysis is given of various factors that reduce the image quality obtained with range optical systems, factors such as meteorological conditions, lens quality, detector response characteristics, etc. Research that has been and is being carried out is outlined, and an examination is made of the usefulness of this work. Author

**N65-13163#** Aeronautical Research Council (Gt. Brit.)
**MEASUREMENTS OF THE FREE STREAM TURBULENCE IN THE R.A.E. BEDFORD 13 ft. × 9 ft. WIND TUNNEL**
D. H. Ferriss London, HMSO, 1964 13 p Supersedes NPL-AERO-1066, ARC-24926; see X64-13183 09-10
(ARC-CP-719; NPL-AERO-1066; ARC-24926) HMSO: 3s

The rms fluctuation level in the longitudinal direction was 0.02% at 50 fps, rising to 0.04% at 200 fps; in the vertical and horizontal (transverse) directions it was 0.02% rising to 0.10% for the same speed range. These results are given together with a short description of the tunnel and of the technique and apparatus used. Author

**N65-13177#** Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati
**CONSTRUCTION AND OPERATION OF A SINGLE GAP SPARK CHAMBER**
R. Habel, T. Letardi, and R. Visentin 15 Sep. 1964 13 p refs *Its* Nota Interna No. 258
(LNF-64/46)

The described spark chamber has a cross section area of 400 $cm^2$ and the distance between the conducting plates (Al, 2-cm thick) is 22 cm. The coincidence pulse between two scintillation counters defines a charged particle (cosmic ray) crossing the chamber. The chamber operates under various pressures and with various gases: neon, argon, helium, etc. Photographs and graphs are presented showing the result of several measurements. P.V.E.

**N65-13299*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**SPACE PROGRAMS SUMMARY NO. 37-30, VOLUME III FOR THE PERIOD SEPTEMBER 1, 1964 TO OCTOBER 31, 1964. THE DEEP SPACE NETWORK**
W. H. Pickering 30 Nov. 1964 119 p ref
(Contract NAS7-100)
(NASA-CR-59913; JPL-SPS-37-30, Vol. III) OTS Prices: HC $4.00/MF $0.75

The Deep Space Network (DSN) is a precision communication system that is designed to communicate with, and permit control of, spacecraft designed for deep space exploration. The DSN has facilities for simultaneously controlling a newly launched spacecraft and one already in flight. The Deep Space Instrumentation Facility section of DSN utilizes large antennas, low-noise phase-lock receiving systems, and high-power transmitters located at stations positioned at approximately 120° intervals around the earth. Discussed in the report on DSN activities are the following subjects: tracking station engineering and operations; space-flight operations; radio-frequency systems; communications engineering; communications development and research; and advanced antennas. P.V.E.

**N65-13320#** Oklahoma U. Research Inst., Norman.
**A LOW SPEED WIND TUNNEL FOR MEASURING THE EFFECT OF WIND ON BUOYANT DIFFUSION FLAMES**
J. R. Welker and C. M. Sliepcevich 25 Sep. 1964 49 p refs Prepared for NBS
(Contracts OCD-OS-62-89; NBS CST-1142)
(TR-1; AD-607279) OTS: $3.00

The purpose of the equipment described in this paper is to provide the environment necessary to study the behavior of flames from liquid pools under the influence of wind. The equipment includes a wind tunnel with supporting blower, appropriate calming section, and observation and control room; the burner trays; and a fuel delivery system. The design of the tunnel and equipment is based on information available in the literature. A short theoretical discussion is given, and some data from the literature are used to support a slight modification of a previous method of flame representation. Literature data are also used to show the possibility of correlating the expected data in a new way. The results of this new correlation are dependent upon wind properties only, and are independent of flame properties. Author

# 12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

**N65-12350** Illinois U., Urbana. Charged Particle Research Lab.
**THE STABILITY OF ELECTRIFIED LIQUID SURFACES**
John Matthew Schneider 5 Mar. 1964 108 p refs
(Grants AF-AFOSR-107-63; AF-AFOSR-107-64; NSF GP-2372; NSF G-19776)
(CPRL-2-64; AD-604431)

The emphasis is placed upon the stability conditions that apply to liquids sprayed from a small cylindrical capillary

tube. For the low flow rates a particular value of applied electric potential exists, above which the liquid surface is unstable due to electrostatic forces. This potential is defined as the minimum spraying potential. Calculations of the value of the minimum spraying potential are made using a modification of a theory originated by Rayleigh. The instability of the surface of a perfect dielectric is discussed. It is shown that it is impossible to spray uncharged droplets electrically. For the case of high flow rates the jet is unstable under the action of surface tension provided that the wavelength of any disturbance on the jet is greater than the circumference of the jet. If charge is present on the jet, the forces due to the charge promote stability if the wavelength of the disturbance is greater than 0.6 times the circumference of the jet. Author

**N65-12411*#** Toronto U. (Canada). Inst. for Aerospace Studies
**INITIAL PERFORMANCE STUDY OF THE UTIAS HIGH ENERGY MOLECULAR BEAM FACILITY**
D. R. O'Keefe Aug. 1964 58 p refs
(NASA-CR-59667; UTIAS-TN-75) OTS Prices: HC $3.00/MF $0.50

A mixture of 99.0 mole % helium and 1 mole % argon was expanded through an orifice into a high-vacuum region. A conical sharp-edged skimmer was placed on the center line of the expanding flow. A movable source made it possible to vary the source-skimmer distance and investigate the effect of this variable on the flux and spatial distribution of the beam in a collimation chamber downstream. In all cases, the resulting beam was found to be enriched in the heavier species (argon). Collisions between the light and heavy particles tend to yield a beam in argon that has a directed velocity approaching that of the helium. Some of the parameters influencing the increase in the mole fraction of argon were investigated. For the experimental conditions used, results suggest that free molecular flow of both gases through the skimmer entrance is the condition for this enrichment to be a maximum. Author

**N65-12412*#** Michigan U., Ann Arbor. Lab. for Fluid Flow and Heat Transport Phenomena
**CAVITATION DAMAGE CORRELATIONS FOR VARIOUS FLUID-MATERIAL COMBINATIONS Technical Report No. 14**
Frederic G. Hammitt, M. John Robinson, Clarence A. Siebert, and Fazil A. Aydinmakine Oct. 1964 114 p refs *Its* Rept.-03424-14-T
(Grant NsG-39-60; ORA Proj. 03424)
(NASA-CR-59666) OTS Prices: HC $4.00/MF $0.75

Cavitation damage tests on a variety of materials in water and mercury have been carried out. This report summarizes the quantitative data available to date, and various significant conclusions are reached. Cavitation damage data on stainless steel, refractory materials, carbon steel, aluminum, plexiglas, and a series of copper and nickel alloys of varying heat-treats, are presented. An attempt to correlate the data with material properties, degree of cavitation, and velocity effects shows that a single material property is not sufficient. Velocity effects are shown and explained in relation to changes in local flow conditions. Pressure profiles for the various cavitation conditions, including three-pressure tap locations on the surface of the test specimens, are also shown and related to the damage. Author

**N65-12421#** Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
**THE SLOW VISCOUS FLOW OF AN INCOMPRESSIBLE FLUID THROUGH A CONSTRICTION**
F. Edward Ehlers Aug. 1964 17 p ref
(DI-82-0367)

An approximate solution is given for the slow viscous flow of an incompressible fluid through a constricting channel that consists of one straight and one curved wall. The flow is assumed to be laminar, and the pressure is assumed to be constant throughout each cross section. The inertial terms in the momentum equations are neglected, in comparison with the viscous friction terms. Specific formulas are given for the volumetric rate-of-flow through a channel whose curved wall is either a parabolic or a circular arc. Graphs of the dimensionless volumetric rate-of-flow for a practical range of the geometric parameters are also included. Author

**N65-12464#** McGill U., Montreal (Canada). Mechanical Engineering Research Labs.
**NON-EQUILIBRIUM SUPERSONIC NOZZLE FLOW OF THE $N_2 + N_2O_4$ YIELD $N_2 + 2NO_2$ SYSTEM**
Roa Ling Wang Oct. 1964 156 p refs
(Grant DRB 9550-06)
(Rept.-64-16)

Analyses were made for the general case of chemical nonequilibrium effects in one-dimensional, two-dimensional, and axisymmetric nozzle flows. The working fluid is assumed to be a mixture of n chemically reactive species. The method of characteristics was applied to the solution of the nozzle flow problem in the two-dimensional and axisymmetric field. Numerical examples computed on the IBM 7040 are given for supersonic nozzle flow of the $N_2 + N_2O_4 \rightleftharpoons N_2 + 2NO_2$ system. Separate FORTRAN programs are included for the five different cases considered. Two of the programs performed the calculations for equilibrium flow and nonequilibrium flow in a unidirectional field. The remaining three programs are for equilibrium, nonequilibrium, and frozen flow in the two-dimensional field. The calculated results indicate that for small expansion angles the one-dimensional analysis is quite accurate. Author

**N65-12478#** AVCO-Everett Research Lab., Everett, Mass.
**$CO_2$ RELAXATION PROCESSES IN SHOCK WAVES**
Morton Camac Oct. 1964 27 p refs
(Contracts AF 04(694)-414; DA-19-020-AMC-0210; Proj. Defender)
(AVCO-Everett Res. Rept.-194; BSD-TDR-64-96; AD-450965)

The structure of shock waves in $CO_2$ has been observed from Mach 5 to 25. The density variation through the shock and in the downstream region was measured with an electron-beam technique. The vibrational energy in the $CO_2$ $\nu_3$ vibration mode was determined by the infrared emission in the 4.3$\mu$ band. In order to have thick shock waves, a 24-in.-diam shock tube was operated at initial pressures from 0.015 to 0.12 torr. At low shock velocities, the rotation and translation modes relax together in the shock wave to complete equilibrium. Vibration relaxation starts immediately in the downstream region, and all four $CO_2$ vibration modes relax at the same rate. Author

**N65-12486#** General Applied Science Labs., Inc., Westbury, N.Y.
**PRESSURE EFFECTS DUE TO AIR INJECTION INTO A TURBULENT BOUNDARY LAYER ON A FLAT PLATE**
Constantino Economos Sep. 1964 38 p refs
(ARPA Order 460)
(TR-469; AD-450344)

The interaction between the external stream and the turbulent viscous layer on a flat plate generated by normal injection of air through the surface is investigated analytically. It is assumed that the compressible boundary-layer equations are valid and that they can be transformed to an incompressible form by an appropriate stretching of the coordinates and flow variables so that certain results of incompressible theory can be utilized. The problem is idealized by considering the intensity of the mass transfer to be an unknown function of a streamwise coordinate, to be determined by the requirement that the resulting inviscid flow deflection be constant. This effectively reduces the boundary-layer problem to one of constant pressure. The viscous layer thus formed is equivalent to a fluid "wedge" with leading edge located at the station where injection is initiated. For given upstream conditions and for a particular choice of wedge inclination, the theory predicts the required injection distribution as well as the associated boundary-layer properties, such as skin friction and momentum thickness. Author

**N65-12502*#** Ling-Temco-Vought, Inc., Dallas, Tex.
**EFFECTS OF SPIRAL LONGITUDINAL VORTICES ON TURBULENT BOUNDARY LAYER SKIN FRICTION**
J. G. Spangler and C. S. Wells, Jr. Washington, NASA, Dec. 1964 41 p refs
(Contract NASw-956)
(NASA-CR-145) OTS Prices: HC $2.00/MF $0.50

As a part of an experimental investigation of the effects of ordered mixing on turbulent skin friction, spiral longitudinal vortexes were generated in a turbulent boundary layer. (The boundary layer was formed on the test section wall of a facility designed especially for low-speed boundary-layer studies. Screening tests that resulted in the choice and optimization of standard rectangular planform wall-mounted elements for producing this type of vortex are described. Skin friction and velocity profiles were measured as a function of longitudinal and transverse distance for several element configurations, and for the same flow condition. Element heights of 2%, 10%, and 20% of the boundary-layer thickness were used. Effects on skin friction of the vortex-producing elements were measured up to 87 element heights downstream. Direct measurement of the element form drag was also made. Author

**N65-12536** United Kingdom Atomic Energy Authority, Harwell (Gt. Brit.)
**INTERPRETATION OF PRESSURE DROP DATA FROM AN ANNULAR CHANNEL**
G. F. Hewitt Jul. 1964 19 p refs
(AERE-R-4340) HMSO: 3s

Equations are derived by which, provided the pressure drop is known, it is possible to determine the parameters of flow in an annulus having one smooth surface and one rough surface. The flow is divided into two regions, bounded by the plane of zero shear or maximum velocity; and Reynolds numbers, friction factors, etc., are defined for each region. The von Kármán velocity-deficiency law is invoked to provide the key extra equation required in the solution. Author

**N65-12545#** Lincoln Lab., Mass. Inst. of Tech., Lexington.
**NUMERICAL METHODS IN THE CHEMICAL KINETICS OF HIGH TEMPERATURE AIR** **Technical Report No. 361**
L. B. Raisty 29 Jul. 1964 42 p refs
(Contract AF 19(628)-500; ARPA Order 166; Proj. Defender)
(ESD-TDR-64-356; AD-449857)

A computer program is described that performs a one-dimensional gas kinetic calculation, with rate chemistry and vibrational relaxation, when the pressure is a known function of distance. The numerical integration is described in detail. A numerical procedure is presented with which the integration can be continued indefinitely, eventually reaching equilibrium, even when some of the variables reach quasi-equilibrium early in the computation. To demonstrate the capabilities of this procedure, graphical results are given for pressure functions that approximate the pressure acting on an air particle in the flow field of a reentry object, from a point immediately behind the bow shock to a point far out in the wake. Author

**N65-12660#** Boeing Scientific Research Labs., Seattle, Wash.
**DISTRIBUTION OF TURBULENT ENERGY AND CONCENTRATIONS AT LARGE WAVE NUMBERS** **Flight Sciences Laboratory Report No. 90**
Yih-Ho Pao Aug. 1964 80 p refs
(DI-82-0369)

For large Reynolds and Péclet numbers, mechanisms for the spectral transfer of turbulent energy and concentration at large wave numbers are proposed. Based on these mechanisms, the turbulent energy spectrum function and the turbulent concentration spectrum functions of species with arbitrary Schmidt numbers are deduced for the whole universal (equilibrium) range. The resulting one-dimensional energy and concentration spectra are compared with experiments. Author

**N65-12673#** Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
**FLOW SEPARATION AND REATTACHMENT BEHIND A DOWNSTREAM-FACING STEP**
A. Roshko and G. J. Thomke Jan. 1964 50 p refs
(SM-43056-1)

Measurements were obtained in supersonic flow over a downstream-facing step on a ducted, axisymmetric body with a 1-ft diameter. Step heights were 0.25, 1.00, and 1.68 in., free-stream Mach numbers were in the range 2 to 4. The turbulent boundary layer had a momentum thickness of about 0.01 in. just ahead of the step. Pressure rise at reattachment is found to be generally in good agreement with Korst's theory. The results are discussed in light of Nash's criticism and modification of Korst's theory. The problem of flow reattachment is reviewed. Author

**N65-12676#** College of Aeronautics, Cranfield (Gt. Brit.)
**THE USE OF PRESTON TUBES TO MEASURE THE SKIN FRICTION IN TURBULENT BOUNDARY LAYERS WITH SUCTION OR INJECTION**
T. N. Stevenson May 1964 13 p refs
(CoA-Aero-173)

A theory is presented that shows how Preston tubes may be used to measure the local skin friction in incompressible turbulent boundary layers over a porous surface through which there is a small suction or injection velocity. The skin friction measurements obtained in an experiment using Preston tubes are in good agreement with those obtained using the integral momentum equation. Author

**N65-12749#** General Motors Corp., Santa Barbara, Calif. GM Defense Research Labs.
**BODY SHAPE EFFECTS ON AXISYMMETRIC WAKES**
L. N. Wilson Oct. 1964 46 p refs
(Contract DA-01-021-AMC-11359(Z); ARPA Order 347; Proj. Defender)
(TR64-02K; AD-450558)

Experimental measurements were made of the distance of transition-to-turbulence of the wake behind hypersonic spherical and blunted-cone models at hypersonic speeds in a ballistic range. Transition distances behind blunt bodies were found to be independent of body shape, but a definite shape effect was observed for slender bodies. A single-shape parameter was determined that successfully correlated all the slender-body data. The transition process was found to be markedly different between blunt- and slender-body flows, the transition occurring rather abruptly behind blunt bodies and being extended over many body diameters for slender bodies. In all cases, the transition distances were independent of body size and flight speed. The correlations were found to break down at high Reynolds numbers where turbulence originated at the recompression region. A method of using the distance to transition in clean wakes to discriminate between blunt and slender bodies is outlined. Author

**N65-12991#** General Electric Co., Schenectady, N.Y. Advanced Technology Labs.
**STUDY OF THE SURFACE FILMS OF GAS NUCLEI (AS RELATED TO CAVITATION AND TENSILE STRENGTH IN WATER)**
L. H. Bernd Sep. 1964 52 p refs
(Contract Nonr-4296(00))
(TIS-64GL143; AD-608094)

Because of its importance to cavitation and to tunnel operation, the formation of surface films on gas nuclei has been investigated. It has been found that extremely rapid dissolution can take place when surface films are absent, giving high tensile strength. Natural protein surface films can prevent dissolution, making for slow or little strength gain. Waters from different sources vary considerably in their ability to form surface films. Contaminates and aging can greatly affect surface film formation. A surfactant can preferentially form a film about nuclei, prevent "natural" films from building up, and thereby markedly speed dissolution. Author

**N65-12992#** Naval Ordnance Lab., White Oak, Md.
**CHARACTERISTICS OF THE TURBULENT BOUNDARY LAYER WITH HEAT AND MASS TRANSFER AT M = 6.7**
James E. Danberg 19 Oct. 1964 157 p refs
(NOLTR-64-99; AD-452471)

Effects of air transpiration and wall temperature on turbulent boundary-layer characteristics were measured on a porous flat plate at M = 6.7. The velocity profile is described by a mixing length analysis, the velocity being in a form similar to the incompressible semilogarithmic law. From this equation, the skin friction was calculated and found to agree with measurements. Heat transfer can be evaluated from Reynolds analogy, experimentally verified with and without air transpiration. Author

**N65-12999#** ARO, Inc., Arnold Air Force Station, Tenn.
**ANALYSIS OF METHODS FOR DETERMINING OUTGASSING RATES**
J. I. Shipp and J. D. Trolinger Arnold Eng. Develop. Center, Dec. 1964 28 p refs
(Contract AF 40(600)-1000)
(AEDC-TDR-64-180; AD-608660)

Methods of determining outgassing rates of materials under vacuum are discussed, with emphasis on the accuracy and limitations of each. Pressure measurement techniques included are rate of evacuation, rate of rise, and a number of conductance methods. Assuming Langmuir's model for sticking probability, it is shown that these techniques can introduce large errors in determinations of desorption rates due to incorrect choice of pumping speed. Instrument calibration procedures and comparisons of results employing different techniques are also given. Author

**N65-13066#** British Hydromechanics Research Assn., Harlow (Gt. Brit.)
**REFERENCES ON GUIDE-VANE PIPE AND DUCT BENDS**
May 1964 11 p refs
(BIB-16)

A bibliography of references on guide-vane pipe and duct bends is presented with abstracts for some of the papers. The references are arranged in chronological order, from 1927 to 1960, and two bibliographies published on the same subject in 1962 are also listed. D.E.W.

**N65-13082#** Syracuse U. Research Inst., N.Y.
**THE WALL-JET IN A LONGITUDINAL PRESSURE GRADIENT Annual Report**
F. Erian and S. Eskinazi 31 Oct. 1964 32 p refs
(Contract Nonr-669(16))
(ME937-6410F; AD-607474)

The effect of a longitudinal pressure gradient on the nature of the shear stress distribution and the mechanism of energy production were studied in an attempt to determine the effect of pressure gradient on the size of the negative energy-production region in the flow field. The apparatus and its arrangement are described, techniques of measuring the static pressure and mean velocity are given, and measurement of turbulence and shear stress is discussed. As a result of experimentation, it is concluded that dp/dx, whether positive or negative, tends to suppress the regions of negative production of energy. D.E.W.

**N65-13107#** New York U., N.Y. Courant Inst. of Mathematical Sciences
**ACCURACY AND LIMITS OF APPLICABILITY OF SOLUTIONS OF EQUATIONS OF TRANSPORT; DILUTE MONATOMIC GASES**
Harold Grad 30 Sep. 1964 23 p refs Chapter from the Proc. of the Intern. Seminar on Transport Properties of Gases, Brown U., 20–24 Jan. 1964
(Contract AT(30-1)-1480)
(NYO-1480-8; MF-42)

The theory of the Boltzmann equation for a simple gas of monatomic molecules is considered. General methods and principles rather than solutions to specific problems, are surveyed. Except in cases where there is a very well-developed theory, such as Laplace's equation, two paths are simultaneously followed: an investigation of the intrinsic meaningfulness of the equations; and the pursuit of results usable for interpretation of physical phenomena. Specifically, this report brings up to date similar surveys contained in articles in the *Handbuch der Physik* (1958) and in the proceedings of the Nice Symposium (1958). The principal advances since that time, a more comprehensive knowledge of the theory of the linearized Boltzmann equation, the approach to free flow, and the approach to a classical continuum are incorporated. D.E.W.

**N65-13156#** Johns Hopkins U., Baltimore, Md.
**ON THE BOUSSINESQ APPROXIMATION AND ITS ROLE IN THE THEORY OF INTERNAL WAVES**
Robert R. Long Sep. 1964 21 p refs
(Contract Nonr-4010(01); Grant WBG-21)
(TR-17(ONR); TR-20(WBG); AD-605433)

Most studies of the dynamics of fluids with weak density gradients use the Boussinesq approximation, which neglects density variations in the inertial terms of the equations of motion. The significance of this approximation is investigated here. As a general matter, care is called for in the use of the approximation if quantities other than the nondimensional density difference are small. Also, the very existence of certain phenomena of interest and importance may depend on the small terms neglected by the Boussinesq approximation. This is illustrated by an investigation of solitary waves in a stratified fluid system. Author

**N65-13173#** Naval Ordnance Test Station, China Lake, Calif. Research Dept.
**WATER-TUNNEL TESTS OF BASE-VENTED TORPEDO MODELS, NOVEMBER–DECEMBER 1963**
T. G. Lang and H. V. L. Patrick Nov. 1964 24 p refs
(NAVWEPS-8559; NOTS-TP-3587; AD-608400)

Tests were performed in a free-surface water tunnel to determine the ventilated-drag characteristics of truncated torpedo models. The streamlined, fully wetted model used for comparison in the experiments was a body of revolution with a fineness ratio of 8:1 and a diameter of 2 inches. The drag based on body volume for most of the vented, truncated models was equal to the drag of the streamlined, fully wetted model. One particular model, with a short, boat-tailed afterbody, was the best of the vented configurations from the standpoint of combined low drag and low airflow. At no time during the tests did any of the models ventilate forward of the base. Author

**N65-13315#** Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
**ANALYSIS OF FREE SHEAR LAYER WITH FINITE INITIAL THICKNESS AND ITS APPLICATION TO BASE FLOW**
T. Toba 14 May 1964 74 p refs
(SM-45943; AD-606982)

A theoretical study is presented that concerns the development of a two-dimensional free shear layer with finite initial thickness. Near the initial point, a nonsimilar solution is found by matching an inner solution for the mixing layer with an outer solution for the shear layer at the edge of the mixing layer. Far from the initial point, an asymptotic similar solution is possible and can be determined uniquely by matching the initial solution with the perturbed asymptotic solution within the common domain of convergence. Application of this study to the base flow problem is aimed at improving the classical Chapman theory by taking into account the expansion of the separated boundary layer at the base, the mass blowing or suction from the body surface with or without inclusion of the base, and the heat-transfer effect. Preliminary numerical results are in general agreement with available experimental data. An extensive program of numerical calculations and an extension of the formulation to cover real-gas effects is underway. Author

# 13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

**N65-12339#** Library of Congress, Washington, D.C. Aerospace Technology Div.
**GEOMAGNETIC RESEARCH BY THE SOVIET SHIP MIKHAIL LOMONOSOV Preliminary Report**
8 Oct. 1964 17 p refs
(ATD-P-64-56; AD-607347)

A description is presented of the twelfth voyage of the Lomonosov and of the ship's capacity and equipment. Also presented is a general discussion of towed magnetometers. Discussed are the results of measuring the Z-component and the total scalar value T of the terrestrial magnetic-field vector with remote-control magnetometers, the sensing units of which are towed in special gondolas behind an iron ship. P.V.E.

**N65-12441*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**RADIOMETRIC OBSERVATIONS OF THE EARTH'S HORIZON FROM ALTITUDES BETWEEN 300 AND 600 KILOMETERS**
Thomas B. Mc Kee, Ruth I. Whitman, and Charles D. Engle Washington, NASA, Dec. 1964 26 p refs
(NASA-TN-D-2528) OTS Prices: HC $0.75/MF $0.50

Results are presented from theoretical calculations and experimental measurements of sunlit horizons in the middle-ultraviolet region (0.23$\mu$ to 0.29$\mu$), the visible region (0.29$\mu$ to 1.0$\mu$), and the near-infrared region (0.75$\mu$ to 3.0$\mu$). Experimental measurements are reported in the far-infrared region (1.8$\mu$ to 25$\mu$). The data were obtained with a four-channel radiometer, which was flown on a Javelin rocket from the NASA Wallops Station Results indicate that the horizons in the 0.75$\mu$ to 3.0$\mu$ spectral band are strongly affected by clouds. Horizons in the 0.29$\mu$ to 1.0$\mu$ spectral band are located at slightly higher altitudes than those of the 0.75$\mu$ to 3.0$\mu$ spectral band, and, for this measurement, were probably produced principally by scattering. In the 0.23$\mu$ to 0.29$\mu$ spectral band, the horizons were at altitudes significantly higher than those of 0.29$\mu$ to 1.0$\mu$ or 0.75$\mu$ to 3.0$\mu$. These horizons were probably formed by scattering, in the presence of atmospheric ozone. It is theoretically predicted that the peak of this ultraviolet-horizon profile is at approximately 58 km. The horizons that were measured in the 1.8$\mu$ to 25$\mu$ spectral band exhibited a wide variation, which indicated an effective temperature difference. The extreme effective temperatures that were measured are 205° and 270° K. Author

**N65-12446#** Alaska U., College. Geophysical Inst.
**LATITUDINAL AND SEASONAL VARIATIONS IN THE NIGHT AIRGLOW Geophysical Research Report No. 10**
T. N. Davis and L. L. Smith (Natl. Bur. of Standards) Aug. 1964 56 p
(UAG-R156)

A four-color turret photometer has been used for shipboard observations of the night airglow and the aurora. Zenith observations have been obtained close to the 70° W meridian from the northern auroral zone to the Antarctic pack ice. Most of the observations were taken during the Southern Hemisphere winter. Maximums in the [OI] 5577 Å intensity were found near 30° to 40° N and 40° S, with the Southern Hemisphere level being generally lower than that in the Northern Hemisphere. The [OI] 6300 Å latitudinal variation was similar to that of OIÅ 5577 Å except that maximums in the latitudinal distribution were found near 15° geomagnetic north and south latitudes. In contrast with the [OI] emissions, the sodium group (NaD doublet and OH bands near 5893 Å) generally increased to the south with maximums near 20° to 30° N and 40° to 50° S geographic latitude. The total 5340 Å background increased from north to south. Author

**N65-12461#** Weapons Research Establishment (Australia). Dept. of Supply
**A MODIFIED PHOTOCHEMICAL THEORY OF THE OZONOSPHERE**
B. G. Hunt Oct. 1964 30 p refs
(WRE-TN-PAD-21)

When data confirmed by recent laboratory studies is used in photochemical $O_3$ calculations, unacceptably high $O_3$ concentrations and total $O_3$ amounts are obtained. Very good agreement can be obtained with observations in the stratosphere by incorporating reactions involving $O_3$ and electronically excited atomic oxygen, $O(^1D)$, in the overall reaction scheme. Above about 50 km the modified theory gives $O_3$ concentrations that are too high, but it is suggested that this is due to the exclusion of reactions involving $O_3$ and atomic hydrogen in the present study. The importance of $O(^1D)$ to the photochemistry of the ozonosphere cannot be fully assessed however until the rate of deactivation of $O(^1D)$ in the atmosphere has been measured. Author

**N65-12513#** Alaska U., College. Geophysical Inst.
**HIGH LATITUDE GEOPHYSICAL DATA**
1 Jun. 1964 24 p
(UAG-C-33)

This study of high-latitude geophysical data covers the period from July to December, 1963. Observed were the earth's polar, ionospheric current-amplitude activity, the polar, ionospheric current fluctuations, and the daily polar, ionospheric magnetic activity. G.G.

**N65-12515** Joint Publications Research Service, Washington, D.C.
**NUMERICAL EXPERIMENTS IN HYDROLOGY**
G. P. Kalinin, L. S. Kuchment, and V. I. Koren' 3 Dec. 1964 12 p refs Transl. into ENGLISH from Meteorol. i Gidrol. (Moscow), no. 11, Nov. 1964 p 16–22
(JPRS-27678; TT-64-51863) OTS: $1.00

Examples are discussed that show that the use of numerical experiments makes it possible to broaden such operationally important concepts as runoff curves and the velocity of motion of the peaks of long waves. In particular, it was established that the high water dropoff curves, as a result of the regulating effect of a channel, have an extremely sloping branch at the high water end; that there is a critical slope at which the velocity of the peak becomes minimal; and that the construction of a series of reservoirs, accompanied by a decrease of slopes and an increase of depths, can lead to a sharp increase of the rate of movement of the high water wave and thus can lead to a considerable increase of the maximum water discharge. D.E.W.

**N65-12543#** Defence Research Board, Ottawa (Canada). Directorate of Scientific Information Services.
**ON THE SECULAR VARIATION OF THE GEOMAGNETIC FIELD**
Carlo Depietri Jul. 1964 13 p refs Transl. into ENGLISH from Atti Soc. Nat. Mat. Modena, v. 92, 1961 p 3–14
(DRB-T-23-1; AD-449835)

A regional series of annual secular variation values are derived and analyzed. The earth is envisioned as subdivided into eight regions, four to the north of the equator and four to the south, bounded by meridians 80° E, 170° E, 260° E and 350° E. Smoothed annual total intensity data for each region are plotted by the year from 1850 for those regions where such early data are available, or for the earliest date after 1850 for the other regions. Curves of the four Northern Hemisphere regions are substantially alike, with a maximum around 1940 and a minimum between 1911 and 1918; a prior maximum in 1877 and 1882, respectively, is shown in curves of regions I and II. Numerical values suggest a positive mean ordinate for regions I and II and a negative one for regions III and IV. An 11-year cyclic RV component of probable solar origin and a 55-year periodicity is noted. Data for the Southern Hemisphere are much more sparce, and the effects on the curves of using fewer data points are discussed in detail. The regions show mutually discrepant curves, but trends toward 11- and 55-year periodicity are suggested, as well as a 22-year cycle in region VII, close to Hale's solar activity cycle. M.P.G.

**N65-12544#** Naval Postgraduate School, Monterey, Calif.
**NUMERICAL ANALYSIS AND PREDICTION OF CLOUD AND PRECIPITATION PATTERNS**
E. Lee Geraldson and C. D. Clower (M.S. Thesis) 1964 33 p refs
(AD-603432) OTS: $2.00

The numerical weather model used in this paper utilizes vertical velocities and dew-point depressions at the levels of 850, 700, and 500 mb as inputs to a diagram that determines the accompanying weather parameter. Good results were obtained for a current analysis, but the prognosis scheme that was used proved to be unsatisfactory now. The model is programed for the 1604 digital computer, in order to utilize the operational output of machine-processed data and analysis produced by the U.S. Navy Fleet Numerical Weather Facility (FNWF), Monterey, California. Author

**N65-12583#** Aberdeen Proving Ground, Md. Ballistic Research Labs.
**POSITION PREDICTION FOR ACQUISITION IN SATELLITE GEODESY**
R. B. Patton, Jr. Aug. 1963 21 p refs
(BRL-1219; AD-428301)

In a search for greater accuracy in geodetic measurement, a program is underway in satellite geodesy. This is a method of spatial triangulation that requires photographic observation of an identified satellite at three or more points on the earth's surface. The SPADATS orbital parameters are used to predict the position of satellites relative to the tracking station site. These predictions provide a very reliable means of acquisition. The computing method for converting the orbital parameters to position as a function of time is presented in detail. In addition, methods are described for estimating the amount of sunlight that is expected to be reflected to tracking stations by passive satellites such as ECHO. Author

**N65-12637#** Boeing Scientific Research Labs., Seattle, Wash. Geo-Astrophysics Lab.
**GEOPHYSICAL EFFECTS OF HIGH ALTITUDE NUCLEAR EXPLOSIONS**
J. F. Kenney and H. R. Willard Aug. 1964 64 p refs Presented at the Regional IQSY Meeting, Buenos Aires, 3–8 Aug. 1964
(DI-82-0372)

This paper presents a review of the effects of nuclear testing, with special emphasis on the trapped radiation, the ionosphere, and magnetic disturbances. An interpretation of these different phenomena is made. Author

N65-12648# Isotopes, Inc., Westwood, N.J.
**PROJECT STAR DUST Ninth Quarterly Report**
Herbert W. Feely, Ben Davidson, James P. Friend, Raymond J. Lagomarsino, and Micah W. M. Leo 1 Sep. 1963 337 p refs
(Contract DA-49-146-XZ-079)
(DASA-1309; AD-606712)

Filter samples of stratospheric radioactivity were collected by several different aircraft. Radiochemical and radiometric procedures are described. Electron microscope measurements of stratospheric particles provided data consistent with the vertical concentration profile previously reported and with the existence of a stratospheric aerosol in thin, cloudlike laminae. The stratospheric burden of nuclear debris increased to unprecedented values in the Northern Hemisphere as a result of the 1961 and 1962 Soviet test series. Measurements are reported for strontium-90, barium-140, antimony-124, manganese-54, iron-55, beryllium-7, lead-210, polonium-210, carbon-14, and cesium-137 that were made at various times, places, and altitudes. Conclusions are drawn about atmospheric mixing and transfer, tropopause circulation, and the nature of the Soviet tests. D.E.W.

N65-12651# Alaska U., College. Geophysical Inst.
**THE DETERMINATION OF THE SPATIAL DISTRIBUTION OF AURORAL LUMINOSITY Final Report**
G. J. Romick and A. E. Belon May 1964 200 p refs
(NSF G-15725)
(UAG-R149)

The spatial distribution of the auroral luminosity in various emissions was observed by two multichannel photometer systems during the spring of 1960. The height of the peak intensity and the location of the forms were determined by triangulation, and a computer program was developed using synthetic aurora models. It is concluded that, by the use of this double observation system in contrast to former observations from single stations, a more accurate height and location determination of auroral luminosity can be made. G.G.

N65-12758# Army Cold Regions Research and Engineering Lab., Hanover, N.H.
**SNOW AND ICE ON THE EARTH'S SURFACE. COLD REGIONS SCIENCE AND ENGINEERING. PART II: PHYSICAL SCIENCE, SECTION C: THE PHYSICS AND MECHANICS OF ICE**
Malcolm Mellor Jul. 1964 173 p refs
(CRREL-II-C1; AD-449925)

This monograph summarizes existing knowledge on cold regions science and engineering. Areas considered include the natural forms of ice, glaciers, deposition and accumulation of snow, snow metamorphism and ice formation, glacier flow, wastage of glacier ice, mass economy and glacier fluctuations, temperatures in glaciers, past glaciations, sea ice, and glaciological techniques. A bibliography is included with each chapter. D.E.W.

N65-12776# Alaska U., College. Geophysical Inst.
**IONOSPHERIC RADIO WAVE ABSORPTION EVENTS AND THEIR RELATION TO SOLAR PHENOMENA**
Roy P. Basler and Leif Owren Jul. 1964 206 p refs
(NSF GP-947; NSF GP-169)
(UAG-R152)

High-latitude radio-wave absorption data collected over a period of 6 years showed that the polar cap absorption and the auroral absorption are caused by different types of solar particle emissions. It was found that particle streams ejected from sun flares induce the onset of PCA, and that long-lived streams of low-energy particles that are attributed to the solar M-regions give rise to recurring magnetic storms, auroras, and auroral-zone radio-wave absorption, but not to PCA or other high-energy phenomena. G.G.

N65-12786# Atomic Energy of Canada Ltd., Chalk River, Ontario.
**ESTIMATION OF DOWNWIND CONCENTRATION OF AIRBORNE EFFLUENTS DISCHARGED IN THE NEIGHBOURHOOD OF BUILDINGS**
P. J. Barry Jul. 1964 18 p refs Presented to the Advisory Comm. on the Safety of Particle Accelerators of the Atomic Energy Control Board, Sep. 1963
(AECL-2043) Available from Atomic Energy of Canada, Chalk River: $0.50

The airflow in the neighborhood of buildings is briefly described and compared with that assumed for the usual atmospheric diffusion equations. The literature is reviewed, and empirical formulas that have been proposed are listed and compared. Author

N65-12808*# National Aeronautics and Space Administration, Washington, D.C.
**CONTRIBUTION TO THE STUDY OF THE STRUCTURE OF THE IONOSPHERE [CONTRIBUTION A L'ETUDE DE LA STRUCTURE DE L'IONOSPHERE]**
Marcel Nicolet (M.S. Thesis—Brussels U., 1945) Dec. 1964 184 p refs Transl. into ENGLISH from FRENCH
(NASA-TT-F-253) OTS Prices: HC $3.00/MF $1.25

The properties of the ionosphere are examined from observations of the propagation of electromagnetic waves. After the initial presentation of ionospheric characteristics, the spectral properties of the sun are examined, taking into account the various results of theory and observation. Radiations that are important in the ionization of the atmosphere are deduced. Results of observations of the emission of night airglow and auroras are used to determine the atomic and molecular constitution of the upper layers, and to refine certain points concerning the vertical distribution of the atoms and molecules. A determination of the principal mechanisms of electron–ion equilibrium is undertaken with the aid of kinetic and quantum properties in order to apply them to the atmosphere. General ionization equations are presented, and a physical interpretation of the ionosphere is given. D.E.W.

N65-12812*# California U., La Jolla.
**RELAY I TRAPPED RADIATION MEASUREMENTS**
C. E. Mc Ilwain, R. W. Fillius, J. Valerio, and A. Dave Washington, NASA, Dec. 1964 37 p refs Previously announced as NASA-CR-59023; see N64-33123 24-28
(Contracts NASr-116; NAS5-1683)
(NASA-TN-D-2516; NASA-CR-59023) OTS Prices: HC $2.00/MF $0.50

Instruments aboard the Relay I satellite measured the intensities of geomagnetically trapped electrons with energies greater than 0.45 MeV and of protons in four energy ranges between one and 60 MeV over the region between 1.2 and 2.3 earth radii during the year 1963. The equatorial intensity of electrons ($E > 0.45$ MeV) was found to decrease monotonically from a maximum intensity of about $0.7 \times 10^8$ at 1.3 earth radii down to $10^5$ $sec^{-1}$ $cm^{-2}$ $ster^{-1}$ at 2.3 earth radii. The principal maximum in the proton intensities was found to occur on consistently higher lines of force and with increasing

intensities toward lower energies, so that a maximum intensity of about $3 \times 10^6$ protons (E > 1.1 MeV) $sec^{-1}$ $cm^{-2}$ $ster^{-1}$ occurs at about 2.3 earth radii compared with the maximum of $1.95 \times 10^3$ protons (E = 40 to 110 MeV) $sec^{-1}$ $cm^{-2}$ $ster^{-1}$ at 1.5 earth radii. Author

**N65-12879#** Defence Research Board, Ottawa (Canada). Directorate of Physical Research
**GEOGRAPHICAL DISTRIBUTION OF SUPERSTRUCTURE ICING IN THE NORTHERN HEMISPHERE**
Moira Dunbar Sep. 1964 6 p refs
(G-15)

Three maps show the areas of serious icing probability for the winter months (January to March), for May, and for November. The southern limit is based on 10% frequency of temperatures below 32° F. The northern limit is the edge of the pack ice, which inhibits the formation of spray. Probabilities within the icing zone vary from 1% at the southern boundary to over 50% near the edge of the pack ice. The May and November maps show a marked difference. In spring, the retreat of the pack-ice edge is much slower than the northward movement of the isotherms, so that the area of potential icing is greatly reduced. In the fall, the formation of ice lags behind the drop in air temperature so that the area where icing is to be expected is as large, or larger, than in winter months. R.L.K.

**N65-12902#** Ohio State U. Research Foundation, Columbus.
**ON THE ACCURACY OF THE COEFFICIENTS IN A SERIES OF SPHERICAL HARMONICS Scientific Report No. 7-1**
G. L. Strang van Hees Apr. 1964 29 p refs *Its* Rept.-40
(Contract AF 19(628)-2771)
(AFCRL-64-573; AD-605359)

Usually the coefficients are determined by numerical integration. Therefore, the surface of the sphere is divided into small surface elements, and the mean value of the function for each surface element is estimated. Two sources of error are distinguished: representation error, the error of the estimation of the mean value of the function for each surface element; and integration error, the error caused by the replacement of the integral by a numerical integration. Both errors are separately investigated, and two examples are considered. Author

**N65-12908#** Pennsylvania State U., University Park. Ionosphere Research Lab.
**A SUMMARIZATION OF TECHNICAL AND SCIENTIFIC REPORTS ISSUED BY THE IONOSPHERE RESEARCH LABORATORY—PAPERS PRESENTED AND PUBLISHED Scientific Report No. 200**
A. H. Waynick 1 Dec. 1963 450 p refs
(Contract AF 19(628)-4014)
(AFCRL-64-815; AD-607538)

Abstracts and summaries of technical and scientific reports prepared since 1948 are presented. Subjects covered include radio propagation, ionospheric absorption, polarization studies, instrumentation, antenna systems, auroral studies, and in-flight behavior of payloads. In addition to a complete listing of technical and scientific reports, papers presented at technical and scientific meetings, and papers published in the technical and scientific literature are listed. P.V.E.

**N65-12911#** Pennsylvania State U., University Park. Ionosphere Research Lab.
**EFFECT OF TEMPERATURE CHANGES ON THE ELECTRON DENSITY DISTRIBUTION IN THE F-REGION Scientific Report No. 226**
Y. V. Somayajulu 1 Dec. 1964 27 p refs
(Contract AF 19(628)-4014; NSF GP-2914)
(AFCRL-64-853; AD-608759)

The effect of temperature changes on the electron density distribution in the F-region is investigated. The initial profile is assumed to correspond to photoequilibrium conditions, with the peak electron density determined by production, loss, and diffusion. The temperature dependence of the production, loss, and diffusion parameters are then introduced, and the modified profiles are obtained for different temperature changes. The results show that following a temperature increase (by a factor $\lambda > 1$) the electron density at all levels decreases. The height of the peak is located using the theoretical expression. The changed peak electron density obtained from the profile agrees well with that computed from the theoretical expression. Thus, it is concluded that the changed electron density distribution up to the peak can be obtained using this procedure. Author

**N65-12913#** Kiruna Geophysical Observatory (Sweden).
**THE POLARIZATION OF GIANT PULSATIONS AT KIRUNA Scientific Report No. 1**
K. V. Paulson, A. Egeland, and F. Eleman 25 Jul. 1964 41 p refs
(Contract AF 61(052)-619)
(AFCRL-64-866; AD-608477)

The polarizations of four of the five giant pulsations recorded during 1963 at Kiruna ($\Phi$ = 67.8° N., $\lambda$ = 20.4° E.) were analyzed by a method that has not been used in previous geomagnetic investigations. This method of analysis is developed in some detail, and gives a quantitative measure of the type and degree of polarization and the principal directions of the resultant vectors in each of three orthogonal planes. In addition, the phase differences between each of the three orthogonal components and the mean or dominant period of the quasi-periodic time variation in each component have been derived from calculated crosscorrelation and autocorrelation functions. For these giant pulsations, attention is drawn to the variance of the vertical component that is of the same order and often larger than the variance of the corresponding north component. Hence, any physical explanation is inadequate if it is based solely on the field-line propagation of transverse hydromagnetic waves. Author

**N65-12918#** Centre National de Recherches de l'Espace, Brussels (Belgium).
**AERONOMIC PROCESSES IN THE IONOSPHERE Final Report**
William Swider, Jr. 30 Sep. 1964 87 p refs
(Contract AF 61(052)-748)
(AFCRL-64-899; AD-608533)

The approximate variation of the solar flux over the solar cycle is discussed. It is shown that at twilight the variation of the atmosphere over a solar cycle becomes more important than the variation of the solar flux in determining ionic production, the variation of the solar flux being more important for an overhead sun. Practical solutions for the optical depth of the terrestrial ionosphere are given. The nighttime ionosphere is described in terms of stationary decay schemes. Various explanations are brought forth for the nighttime E-region, which appears to be the only section of the nighttime ionosphere that departs from stationary decay. The twilight ionosphere is

discussed briefly in terms of the behavior of $N_2^+$ ions. Departures from photoequilibrium are determined. It is noted that the twilight ionosphere is an ionosphere that involves the maximum departure from photoequilibrium. Author

**N65-12953#** Joint Publications Research Service, Washington, D.C.
**NEW DATA ON THE STRUCTURE OF THE EARTH'S CRUST IN THE SEA OF JAPAN**
Yu. P. Neprochnov et al 23 Dec. 1964 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk (Moscow), v. 155, no. 6, 1964 p 1429–1431
(JPRS-27-955; TT-64-51990) OTS: $1.00

Deep-seismic-sounding measurements using refracted and reflected wave methods were made on a 240-mile profile of the northern part of the sea of Japan. It was observed that the earth's crust in the investigated region consisted mainly of two principal layers: the upper, sedimentary rock layer and the lower, basalt layer. Three thicknesses and structural boundaries were traced in the sedimentary layer—the first at a depth of 100 to 200 m, the second at a depth of 800 to 1000 m, and the third at a depth of 1600 to 2000 m below the sea floor. The greatest dissections were characteristic for the upper part of the sedimentary complex. G.G.

**N65-12978#** Naval Research Lab., Washington, D.C.
**RADAR AURORAL ECHOES**
Sandra B. Rutiser *In its* Rept. of NRL Progress Aug. 1964 p 4–10 refs (See N65-12976 03-34)

Radar echoes reflected from the ionosphere have been observed with the 150-foot antenna located at the Chesapeake Bay Annex. These returns have been most frequently observed when the radar beam is oriented in certain favored directions with respect to the earth's magnetic field. Further study has shown that these echoes are associated with the visible aurora, solar flares, geomagnetic storms, and polar blackout of communications. Author

**N65-12979#** National Observatory of Athens (Greece). Ionospheric Inst.
**IONOSPHERIC OBSERVATIONS, SCARAMANGA STATION, AUGUST 1964**
[1964] 29 p *In* GREEK and ENGLISH

The complete ionospheric data gathered during August 1964 in Skaramanga, Greece, are presented in tables. Measurements of ionospheric characteristics at various heights were taken daily in 0.01-minute intervals by an automatic ionospheric recorder covering the frequency bands from 1 to 20 Mc/sec. G.G.

**N65-12980#** National Observatory of Athens (Greece). Ionospheric Inst.
**IONOSPHERIC OBSERVATIONS, SCARAMANGA STATION, SEPTEMBER 1964**
[1964] 29 p *In* GREEK and ENGLISH

The complete ionospheric data gathered during September 1964 in Skaramanga, Greece, are presented in tables. Measurements were taken daily in 0.01-minute intervals to obtain the normal ionograms and other ionospheric characteristics at various heights, using an automatic ionospheric recorder that covered the frequency bands from 1 to 20 Mc/sec. G.G.

**N65-13026#** Air Force Cambridge Research Labs., Bedford, Mass.
**GEOPHYSICS AND SPACE Data Bulletin No. 1**
Anne L. Carrigan and Norman J. Oliver, ed. Jul. 1964 189 p refs

CONTENTS:

1. COMPONENT MAGNETOMETER J. F. Devane (Weston Obs.) 8 p (See N65-13027 03-13)
2. COSMIC RAY NEUTRON INTENSITY MONITOR J. A. Simpson (Chicago U.) 29 p refs (See N65-13028 03-29)
3. OBLIQUE BACKSCATTER RADAR C. Malik 25 p (See N65-13029 03-13)
4. RIOMETER K. Bibl (Lowell Technol. Inst. Res. Found.) 109 p (See N65-13030 03-13)
5. SOLAR RADIO EMISSION. SPECTRAL OBSERVATIONS A. Maxwell (Harvard Coll. Obs.) 5 p (See N65-13031 03-29)

**N65-13027#** Weston Observatory, Mass.
**COMPONENT MAGNETOMETER**
John F. Devane *In* AFCRL Geophys. and Space Jul. 1964 8 p (See N65-13026 03-13)
(Contract AF 19(628)-236)

The standard magnetic observatory at Weston, Massachusetts, is described in geographic and geomagnetic terms. Magnetometer data are presented that were collected at the observatory during January, February, and March 1964. The data include hourly mean values of the geomagnetic elements, total field intensity, and the local index of magnetic activity. The hourly values of each of the geomagnetic elements and of the total intensity represent the mean values for successive periods of 1 hour each. The activity index and the root mean square of the departures of hourly values of total intensity from the daily average are also tabulated. D.E.W.

**N65-13029#** Air Force Cambridge Research Labs., Bedford, Mass.
**OBLIQUE BACKSCATTER RADAR**
Chester Malik *In its* Geophys. and Space Jul. 1964 25 p (See N65-13026 03-13)

An oblique-incidence ionospheric sounder that has been in operation at Newburyport, Massachusetts, for several years is described. Photographs of typical PPI displays of auroral and field-aligned returns and of F-layer returns are presented, as are a series of records of oblique backscatter that give azimuth and range hourly for the period January through March, 1964. D.E.W.

**N65-13030#** Lowell Technological Inst. Research Foundation, Mass.
**RIOMETER**
Klaus Bibl *In* AFCRL Geophys. and Space Jul. 1964 109 p (See N65-13026 03-13)
(Contract AF 19(628)-8371)

Five types of ionospheric absorption are distinguished and described. The theory, apparatus, and operation of the riometer (Relative Ionospheric Opacity Meter) are described. Riometer records are included that were taken during January, February, and March, 1964, at Huancayo, Peru; Manila, Philippines; Maui, Hawaii; New Delhi, India; Sao Jose dos Campos, Brazil; and Thule, Greenland. D.E.W.

N65-13078# Institut Royal Meteorologique de Belgique, Brussels.
**MICROCLIMATIC STUDIES, PAMPHLET III [ETUDES MICROCLIMATIQUES, OPUSCULE III]**
S. M. de Backer and A. Vanderplas 1964 48 p refs In FRENCH *Its* Ser. A, Nr. 50

CONTENTS:

1. MICROCLIMATE OF A POPLAR-GROVE. ZOUTLEEUW (LEAU), 1954–1955. REGISTERING OF INLAND TEMPERATURES AND THOSE IN THE VICINITY OF A *POPULUS ROBUSTA* S. M. de Backer 41 p refs

2. CLIMATOLOGICAL INSIGHT INTO NORTHEASTERN HESBAYE A. Vandenplas 7 p

N65-13097# Weapons Research Establishment (Australia).
**IONOSPHERIC DATA FOR JANUARY 1964 FROM SALISBURY, SOUTH AUSTRALIA**
May 1964 26 p
(CPD-1964/1(S))

Tables of hourly values of the customary ionospheric parameters are given for January 1964 for the station at Salisburgy, South Australia, located at 34.7'S and 138.6'E. The ionosonde is a modified Cossor Portable Ionospheric recorder, Model 7562C (Mk.II). R.L.K.

N65-13098# Weapons Research Establishment (Australia).
**IONOSPHERIC DATA FOR FEBRUARY 1964 FROM SALISBURY, SOUTH AUSTRALIA**
Aug. 1964 26 p
(CPD-1964/2(S))

Tables of hourly values of the customary ionospheric parameters are given for February 1964 for the station at Salisbury. R.L.K.

N65-13099# Weapons Research Establishment (Australia).
**IONOSPHERIC DATA FOR MARCH 1964 FROM SALISBURY, SOUTH AUSTRALIA**
Aug. 1964 26 p
(CPD-1964/3(S))

Tables of hourly values of the customary ionospheric parameters are given for March 1964 for the station at Salisbury. R.L.K.

N65-13100# Weapons Research Establishment (Australia).
**IONOSPHERIC DATA FOR MARCH 1964 FROM WOOMERA, SOUTH AUSTRALIA**
Jun. 1964 24 p
(CPD-1964/3(W))

Tables of hourly values of the customary ionospheric parameters are given for March 1964 for the station at Woomera, South Australia, located at 30.8'S and 136.3'E. The ionosonde is a Union Radio Recorder, Mark II, 1958. R.L.K.

N65-13101# Weapons Research Establishment (Australia).
**IONOSPHERIC DATA FOR MAY 1964 FROM SALISBURY, SOUTH AUSTRALIA**
Aug. 1964 26 p
(CPD-1964/5(S))

Tables of the hourly values of the customary ionospheric parameters are given for May 1964 for the station at Salisbury.

N65-13114 Weapons Research Establishment (Australia).
**IONOSPHERIC DATA FOR APRIL 1964 FROM SALISBURY, SOUTH AUSTRALIA**
Aug. 1964 26 p
(CPD-1964/4(S))

Tables of hourly values of the customary ionospheric parameters are given for April 1964 for the station at Salisbury. R.L.K.

N65-13131# National Oceanographic Data Center, Washington, D.C.
**INTERNATIONAL COOPERATIVE INVESTIGATIONS OF THE TROPICAL ATLANTIC. DATA REPORT: EQUALANT I, VOLUME II**
Albert M. Bargeski and Daniel Roberts, III, comp. 1964 775 p (G-3) Available from Natl. Oceanographic Data Center: $5.00

This volume contains a compilation of the oceanographic station data and associated bathythermograph (BT) data collected during the Equalant I program. These data were forwarded by the originators to the World Data Center A (WDC-A) for Oceanography and processed by the National Oceanographic Data Center. The oceanographic station data are arranged by ship; where a BT was taken at an oceanographic station, a digitized machine listing of the unadjusted BT values at constant intervals is included below the station listing. D.S.G.

N65-13135# Measurement Analysis, Corp., Los Angeles, Calif.
**EXTREME VALUES OF RANDOM PROCESSES IN SEAKEEPING APPLICATIONS**
George P. Thrall Aug. 1964 47 p refs
(Contract Nonr-4305(00))
(MAC-307-03; AD-607912)

A basic mathematical analysis is presented for determining bounds on the probability that a particular random process, such as the height of the sea at a given time, exceeds a predetermined level during an interval of time. Bounds are obtained for two distinct cases; in the first case, only the covariance function of the process is known; and in the second, the joint distribution of the process and its first derivative are known. The results are applied to various seakeeping problems. In particular, bounds on the probability of extreme wave heights are developed and analyzed using the proposed spectrum of Pierson and Moskowitz for fully developed seas. D.S.G.

N65-13166*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**AN ULTRA-LOW FREQUENCY ELECTROMAGNETIC WAVE FORCE MECHANISM FOR THE IONOSPHERE**
J. M. Boyer and W. T. Roberts 5 Oct. 1964 27 p refs
(Contract NAS-11138)
(NASA-TM-X-53147) OTS Prices: HC $2.00/MF $0.50

This report discusses two nocturnal maximum electron-density concentrations 12 degrees above and below the geomagnetic equator, their seasonal variation, and sudden height increases in the F2 layer after twilight. J. M. Boyer's theoretical force mechanism for ionospheric matter is described. It uses a mechanical potential geometry derived from electromagnetic standing waves generated by Mie scattering of ultra-low frequency energy from sun incident on earth. Importance of the $1/\omega^2$ dependence of the time average Lorentz force on charged matter within such a standing wave gradient is emphasized, weighing first-order effects toward the first dipole–multipole resonances of earth in the region 7.0 to 70.0 cps. Computer results for plane-wave scattering from earth in the

above spectral region show the result is a complex wave geometry of three-dimensional potential wells for charged matter. Anomalies in the standing electromagnetic wave field correspond with observed ionosphere anomalies in the F2 region, when translation between the wave coordinate and geographic frames is made. Author

**N65-13175#** Aberdeen Proving Ground, Md. Ballistic Research Labs.
**TELEMETRY EXPERIMENTS CONDUCTED ON THE HARP PROJECT AT BARBADOS, W.I. AND WALLOPS ISLAND, VIRGINIA, DURING THE PERIOD JANUARY–MARCH 1964**
William H. Mermagen Jul. 1964 35 p refs
(BRL-Memo-1578; AD-449867)

A number of the firings in conjunction with the High Altitude Research Project (HARP) involved the use of telemeters to transmit data concerning vehicle performance. Of the five telemetry flights in Barbados, only two transmitted successfully. Two of the three failures are attributable to the vehicle. No data were obtained from the two good flights because of subcarrier oscillator failure. The tests conducted at Barbados and Wallops demonstrated the feasibility of developing radio telemetry for use with vertically fired projectiles. Transmitter power of 0.25 watt seems to be ample for altitudes of up to $10^6$ feet, even with undesirable antenna patterns. D.E.W.

**N65-13183#** Minnesota U., Duluth.
**A NEW RADIATION CHART**
John L. Gergen Aug. 1964 33 p refs
(NSF G-25217)
(AEB-2)

This report presents a form of radiation chart, using Elsasser's 1960 data, and gives instructions for its use. A brief section also indicates comparisons between the atmosphere fluxes calculated using Elsasser's 1942 radiation chart, the chart presented, and the experimental data. The newer data, embodied in this new chart, provide better agreement between theory and experiment, especially at higher altitudes. Author

**N65-13203#** Canterbury U., Christchurch (N. Zealand).
**OBSERVATIONS IN NEW ZEALAND OF GEOMAGNETIC MICROPULSATIONS IN THE 0.008-2.0 c/s BAND Final Report**
B. J. Fraser and C. D. Ellyett Jun. 1964 29 p refs
(Grant Nonr(G)-00020-63)
(AD-607359)

A study was made of 3 1/2 months of data recorded in 1963 from a four-channel narrowband micropulsation apparatus operating in the 0.5 to 2.0 c/s band. Both pearls and impulsive signals were found. Pearls occur in association with sudden magnetic storm commencements (SSC's). Narrowband frequency drifts are also evident in pearl events. Broadband micropulsation studies in the 0.008 to 0.25 c/s band over the period October 1962 to January 1964 reveal solar region activity between the 6th and 9th days of the solar rotation in 10 to the 17 rotations observed. In one case this activity was present for six consecutive rotations, indicating a persistent active region. Preliminary frequency–time analyses of broadband micropulsations recorded on portable transistorized equipment are also included. Author

**N65-13213#** Georgia Inst. of Tech., Atlanta. Engineering Experiment Station
**STUDY OF PHOTOCHEMISTRY, PHYSICAL STATE AND MOTION OF THE UPPER ATMOSPHERE Final Report, 1 Aug. 1963–31 Jul. 1964**
Howard D. Edwards Jul. 1964 58 p refs
(Grant NsG-304-63; Contract AF 19(628)-3305; ARPA Order 42)
(AFCRL-64-700; AD-607059) OTS: $3.00

Analysis procedures are presented for determining mass motions in the upper atmosphere by photographic triangulation and tracking of artificial clouds produced by chemical releases. Techniques are given both for clouds having identifiable features that can be tracked and for trail clouds that have few or no identifiable features. A discussion of various coordinate systems necessary for both the determination of camera orientation and for the triangulation calculations is also included. All of these coordinate systems are suitable for an earth that is assumed to be an ellipsoid of revolution. Author

**N65-13241#** Alaska U., College. Geophysical Inst.
**GYRO-EMISSION FROM AURORAL ELECTRONS Final Report**
R. Parthasarathy Sep. 1964 37 p refs
(Contract DA-ORD-31-124-61-G93)
(AROD-2972-12; AD-450834)

Observations conducted at College, Alaska in the frequency range of 1 to 10 Mc/sec indicate that auroral, primary electrons emit radiowaves in the form of bursts lasting a few seconds. Typically, the bursts show a monotonically decreasing intensity with frequency. On occasions the bursts show enhancements only near the frequencies that are multiples of the fundamental gyrofrequency of 1.5 Mc/sec. On even rarer instances, the radiobursts imply that the particle precipitation is periodic, at the rate of a few hundred cycles per second. Inferences concerning the primary particle spectrum and flux are handicapped by the severe uncertainties in the attenuation of the waves in the path between the emitting region (100 to 300 km level) and the ground; such uncertainties could lead to orders-of-magnitude errors in the derived values of the primary flux. Author

**N65-13243#** Ionosphären-Institut Breisach (W. Germany).
**LARGE SCALE FLUCTUATIONS OF THE IONOSPHERE**
K. Bibl 15 Jul., 1964 54 p refs
(Contract AF 61(052)-623)
(IIB-12; AFCRL-64-900; AD-608474)

An attempt was made to study statistically, without regard to simple tidal effects, the large-scale variation of the F-region ionization. The variability of F-region ionization is large; therefore, information about the amplitudes and periods of oscillations and about propagation direction and speed of movement is at least as important as information about maximum electron density. The dependence of the fluctuations on time of day, and season and latitude seems conclusive for the properties of the high atmosphere. Some results verify previous conceptions about periods and high amplitudes of the fluctuations. They can be described as a quasi-elastic movement of the whole F-layer ionization, which is not completely symmetric. During the layer's downward motion, which produces higher electron densities, there is electron loss at the lower level. In certain cases, during heavy storms, there is also a big electron leakage at the end of the upward motion phase. Author

**N65-13296#** Wisconsin U., Madison. Geophysical and Polar Research Center
**SEABORNE MAGNETIC MEASUREMENTS IN THE CHUKCHI SEA Final Report**
Ned A. Ostenso and Perry E. Parks, Jr. Jun. 1964 33 p refs
(RR-64-5; AD-446515)

Results of an airborne gravity survey of the Chukchi and Beaufort Seas are discussed. The survey revealed +100 mgl free air and Bouguer gravity highs over the northeastern corner of the Chukchi Shelf, centered on 73° N., 160° W. A mean Bouguer anomaly of zero over the shelf is indicated by limited data. A reconnaissance aeromagnetic survey of the Arctic Ocean Basin indicated two anomalies northwest of Barrow. The anomalies are very similar in character and appear to be mutually correlative. A strong suggestion of lineation of the anomalies and the depth calculations suggest the existence of a near-surface dyke or magnetic basement ridge complex striking at an angle of approximately 45° to the margin of the continental shelf. Extensive seismic refraction investigation of the Chukchi Sea confirmed the previous finding that the Chukchi's shelf is continental both in seismic velocity structure and crustal thickness. P.V.E.

# 14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

**N65-12353#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ERROR OF COAXIAL CALORIMETRIC POWER METER DUE TO INEQUALITY OF THERMAL LOSSES**

A. V. Grigor'yev, T. L. Zalutskaya, L. E. Pecherey, and A. I. Smirnov *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 10–23 refs (See N65-12351 03-34)

An attempt is made to derive an approximate expression for the magnitude of the error obtained in reading a calorimetric power meter. The error is considered to be due to the inequality of thermal losses. In the particular meter considered, the unit in which absorption of the measured power occurs, the so-called calorimetric load, is a section of a calorimetric coaxial line. P.V.E.

**N65-12354#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ERROR OF THERMISTOR BRIDGE VIM-1 DURING MEASUREMENT OF PULSE POWER**

V. D. Frumkin *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 24–35 refs (See N65-12351 03-34)

Presented are the main peculiarities of thermistors operating with pulse signal. Considered is the influence of the thermistor resistance to (direct current) flutter when used with a type VIM-1 bridge. The additional measurement errors that arise are connected to the peculiarities of the bridge circuit during pulse modulation of the signal. Author

**N65-12358#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**ABOUT INCREASE OF ACCURACY OF MEASUREMENT OF ATTENUATION BY METHOD OF SQUARE-LAW DETECTOR**

Ye. I. Strelkova *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 71–78 refs (See N65-12351 03-34)

Described is the application of a phase detector on the output of a measuring amplifier of type 28-IM for expanding the limits of measurement and increasing accuracy during attenuation measurement up to 30 dB by a one-step method of the square-law detector. Author

**N65-12364#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**COLLATION OF METHODS OF CHECK OF LOOP FIELD-STRENGTH METERS IN FIELD OF INDUCTION AND IN FIELD OF RADIATION**

V. S. Buzinov *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 132–136 refs (See N65-12351 03-34)

Methods for the calibration and checking of field-strength loop meters in the 12-kc to 50-Mc frequency range are based on the use of the magnetic constituent H of the electromagnetic field of induction. An experiment was conducted to collate the methods of checking the field-strength loop meters in fields of induction and in radiation fields. From the experiments it is concluded that field-strength meters, calibrated or checked in fields of induction, can be applied without additional error for measurement of field strengths in zones of radiation. P.V.E.

**N65-12406#** Royal Armament Research and Development Establishment, Fort Halstead (Gt. Brit.)

**DEVELOPMENT AND USE OF AN ION MACH METER TO CALIBRATE AN ARC-HEATED LOW-DENSITY WIND TUNNEL**

W. A. Clayden *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 981–1012 refs (See N65-12393 03-34)

A method is given that enables a local measurement of ion Mach number to be obtained directly in a flowing partially ionized gas. Essentially, it is shown that the ion Mach number is proportional to the ratio of the saturated ion currents obtained from a double Langmuir probe with electrodes alined parallel and normal to the flow. For the method to be valid it is necessary for the following conditions to hold: (1) Velocity > ion velocity at the sheath edge $\simeq \sqrt{k.T_e/m_i}$. (2) Electron temperature >> ion temperature. (3) Debye length << probe diameter << neutral mean free path. Some preliminary experiments show that these conditions may be obtained in the RARDE arc-heated low-density wind tunnel, and the optimum probe sizes are established. The method of extrapolating the saturated ion currents to their value at plasma potential is discussed. The ion Mach meter is then used to calibrate a contoured nozzle and a free jet. The maximum ion Mach number that is obtained is ~ 2.4, which is in qualitative agreement with a simple model in which the electron temperature is constant throughout the nozzle or jet and equal to the neutral gas stagnation temperature. Author

**N65-12467#** Federal Aviation Agency, Atlantic City, N.J. Systems Research and Development Service

**EVALUATION OF MODULAR MONITOR SYSTEM INDICATOR Final Report**

George W. Gonyou Oct. 1964 39 p (FAA-RD-64-144)

An operational and laboratory evaluation was conducted on a development model of the Modular Monitor System Indicator (MMSI) to determine its suitability for operational use. The system was designed to control, monitor, and communicate with remote air-navigational facilities. The MMSI is to provide operational control of a remote NAVAID, such as switching from main to standby transmitters; monitoring of NAVAID equipment status and condition by alarm indication of malfunctions, as course shift of a VOR; and communication between the Flight Service Station (FSS) and the remote NAVAID. The MMSI is composed of a basic chassis that contains all controls and equipment common to the monitoring of several NAVAID's and of plug-in modules that perform the repetitive functions for each NAVAID. On the results of the

evaluation, it was concluded that the MMSI (with suggested design changes) is a suitable replacement for Monitor Indicator Units presently in service. P.V.E.

**N65-12522#** Bissett-Berman Corp., Santa Monica, Calif.
**RESEARCH ON NON-SEQUENTIAL SCANNER FOR SURVEILLANCE APPLICATIONS Interim Engineering Report No. 1**
John M. Brabant 5 Oct. 1964 47 p
(Contract AF 33(615)-1431)
(C115-4; AD-449376)

The stellar rejection technique is described as a novel solution to differentiate between the brightness of a target and the stellar background. A passive detection system that utilizes visible and ultraviolet radiation from sunlight reflected off the target vehicle is presented in a feasibility model. The model is based on a nonsequential scanning concept that involves the use of two fan beams which are wide in one direction and narrow in beamwidth in the orthogonal direction. The simultaneous use of these beams scanning in orthogonal directions would provide a 1° by 1° accuracy of position location of moving objects while requiring only 180 dwell times. The optical radiation received from the target and the stellar and sky background is fed through a special scanning reticle into an auxiliary optical system that is focused to a photomultiplier tube detector. It was found that multiple light sources of the same angular rates gave the same frequency signals, and that simultaneous targets having different angular rates were separable. G.G.

**N65-12523#** General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation
**REACTOR INSTRUMENTATION AND CONTROL Progress Report No. 85, 1 Sep.–31 Oct. 1964**
30 Nov. 1964 22 p
(Contract AT(40-1)-2847)
(GEMP-85) OTS: $2.00

This progress report describes the preliminary testing of a 1600° C integrated probe and readout system that utilizes a single-crystal sapphire. In several runs the response time of the sensor was tested and compared with that of a thermocouple; it was found that the capacitor sensor lagged behind the thermocouple at a temperature increase of about 50% from the beginning, stabilizing tracing temperature of 1265° C. The development and construction of a single-lead, uncompensated ac ionization chamber that is suitable for operation up to 500° C is also presented. G.G.

**N65-12525#** Air Force Systems Command, Wright-Patterson AFB, Ohio. AF Materials Lab.
**PERFORMANCE AND APPLICATION OF A DOUBLE-BEAM INFRARED SPECTROPHOTOMETER IN THE REGION 350 TO 50 $cm^{-1}$ Technical Documentary Report, Mar. 1963–Apr. 1964**
Adele L. Rozek, Allan D. Davidson, and Neil T. Mc Devitt (Cincinnati U.) Aug. 1964 89 p refs
(ML-TDR-64-192; AD-606972)

A discussion is presented of calibration and performance of a far infrared double-beam spectrophotometer in the region 350 to 50 $cm^{-1}$. The spectrum of the pure rotational absorption bands of water vapor as recorded with a Perkin–Elmer Model 301 is shown for this region. The present work also reports the results of an application study of the far infrared to organic compounds of various classes. Included were a small number of inorganic oxides. Author

**N65-12566#** Army Missile Command, Huntsville, Ala. Inertial Systems Development Branch
**LOW COST ACCURATE SENSOR (AB-30) DESIGN STATUS REPORT II**
W. E. Grunwald 16 Jul. 1964 92 p refs
(RG-TR-64-8; AD-451776)

A study has been made at the Army Inertial Guidance and Control Laboratory to determine what design characteristics and parameters must be followed to design and manufacture a moderate cost and moderate precision stability sensing gyroscope. Various materials have been checked and tested for possible use in the manufacture of the gyrorotor, sensing elements, and gyrocase. Basic comparisons are tabulated and presented. Test results of the first prototype model are included. Author

**N65-12596#** Battelle Memorial Inst., Columbus, Ohio. Radiation Effects Information Center
**THE EFFECT OF NUCLEAR RADIATION ON TRANSDUCERS**
W. E. Chapin, D. J. Hamman, and E. N. Wyler 19 Apr. 1963 142 p refs
(Contract AF 33(657)-10085)
(REIC-25; AD-405431)

This report presents information on the effects of nuclear radiation on various types of transducers that are important in present-day applications. The first section of the report deals with concepts and characteristics of conventional transducers with estimation of values of radiation thresholds. The approach used in the estimation involves contact with users and manufacturers for their opinions and knowledge on the subject, use of known experimental data for materials used in the fabrication of transducers, and some empirical data from experiments with similar units. Information is also included on research and development programs currently in progress or completed. The second section of the report deals with information from reports available at the Radiation Effects Information Center on irradiation of various transducers and sensing elements. Author

**N65-12615*#** Melpar, Inc., Falls Church, Va.
**GAS CHROMATOGRAPHIC INSTRUMENTATION FOR GAS ANALYSIS OF THE MARTIAN ATMOSPHERE. VOLUME I: THIRD MONTHLY LETTER TECHNICAL REPORT Final Report**
J. H. Chaudet 25 Sep. 1962 34 p
(JPL-950326)
(NASA-CR-59769) OTS Prices: HC $2.00/MF $0.50

Successful efforts to integrate all components into a working laboratory model of a gas chromatograph instrument for analysis of the Martian atmosphere are reported. Mechanical developments discussed include the following: (1) the construction and evaluation of an optimum sample injection value; (2) a carrier-gas control system; (3) instrument sealing; (4) loop switching; (5) Martian atmospheric Venturi gas pump; (6) construction of a Martian atmosphere simulator; (7) construction aspects of the laboratory model; and (8) design considerations for the breadboard model. M.P.G.

**N65-12616*#** Melpar, Inc., Falls Church, Va.
**GAS CHROMATOGRAPHIC INSTRUMENTATION FOR GAS ANALYSIS OF THE MARTIAN ATMOSPHERE. VOLUME II: OVERALL PROGRAM SUMMARY Final Report**
J. H. Chaudet 25 Sep. 1962 162 p
(JPL-950326)
(NASA-CR-59773) OTS Prices: HC $5.00/MF $1.00

A laboratory model of a gas chromatographic instrument to analyze 12 components that may be present in the Martian atmosphere is described. The $NH_3$, $CO_2$, $H_2O$, $H_2$, $N_2$, $O_2$, A, $CH_4$, and CO can be quantitatively measured and $N_2O$, $C_2H_6$, and Kr can be detected, all at a level of 10 ppm, with the exception of ammonia. The system consists of a series arrangement of four major columns and two delay columns, four cross-section ionization detectors paired in sequence, and electrometers to analyze the outputs of each pair of detectors. The discussion includes the following: (1) configuration; (2) performance data; (3) detailed consideration of the various components; and (4) design drawings. Significant engineering research and development aspects are emphasized. M.P.G.

**N65-12617*#** Melpar, Inc., Falls Church, Va.
**GAS CHROMATOGRAPHIC INSTRUMENTATION FOR GAS ANALYSIS OF THE MARTIAN ATMOSPHERE. VOLUME III: POST DESIGN CRITERIA AND SUMMARY** Final Report
J. H. Chaudet 25 Sep. 1962 100 p
(JPL-950326)
(NASA-CR-59772) OTS Prices: HC $3.00/MF $0.75

Post design criteria related to the breadboard and prototype gas chromatography units are considered. Components were selected, and a package configuration is presented. Environmental constraints were considered in the package design. Recommendations are included on the injector valve, columns, detectors, sample pumping, etc. Numerous tradeoffs that were available for increasing the versatility or the reliability of the instrument are also discussed. D.E.W.

**N65-12664#** Joint Publications Research Service, Washington, D.C.
**A METHOD FOR AIRBORNE ACTINOMETRIC OBSERVATIONS IN THE ARCTIC**
A. P. Koptev 15 Dec. 1964 9 p refs Transl. into ENGLISH from Tr. Arkticheskogo i Antarkt. Nauchno.-Issled. Inst. (Leningrad), v. 239, no. 2, 1964 p 134–138
(JPRS-27846; TT-64-51940) OTS: $1.00

This paper describes aircraft instrumentation, consisting of a pyranometer, an albedometer, and thermopiles fastened in a Cardan mounting to insure their horizontal position. The problem of mounting a galvanometer in a Cardan suspension is discussed. Actinometric measurements of solar radiation were made on a constant and horizontal flight course, and the time of observation and the flight altitude were recorded simultaneously. G.G.

**N65-12667#** Joint Publications Research Service, Washington, D.C.
**ELECTRONIC DEVICES FOR PHYSIOLOGICAL INVESTIGATIONS**
Yu. N. Verkhalo 15 Dec. 1964 46 p refs Transl. into ENGLISH of the pamphlet "Elektronnyye Pribory Dlya Fiziol. Issled." (Moscow), no. 536, 1964 p 3–40
(JPRS-27853; TT-64-51945) OTS: $2.00

Described are instruments designed for the study of reaction time and coordination of movements. The instruments for measuring reaction time that are discussed include the following: the chronoelectroperimeter, the spheroreflexometer, a projection reflexometer, a reflexometer with a flat cellular screen, a portable reflexometer for tests in the field, the phonoreflexometer, and a coordination phonoreflexometer. The following instruments for testing the coordination of motions are discussed: FT-IV phonotremometer, FT-2V phonotremometer, tempokinesthesiometer, and instrument for testing motion coordination, and an instrument for studying handwriting characteristics and for training the blind to write. P.V.E.

**N65-12737#** Joint Publications Research Service, Washington, D.C.
**THEORY AND DESIGN OF INSTRUMENTS WITH PACKING-FREE PISTONS**
M. K. Zhokhovskiy 8 Dec. 1964 230 p refs Transl. into ENGLISH of the book "Teoriya i Raschet Priborov s Neuplotnennym Porshnem" Moscow, 1959 p 1–204
(JPRS-27722; TT-64-51883) OTS: $6.00

The following subjects are discussed: "Piston Systems in Measuring Instruments"; "General Equations and Methods of Solution of Problems"; "Flow Rate of Working Fluid in Piston Systems"; Translation Motion of a Piston"; "Distribution of Pressure in the Clearance of Piston Systems"; "Rotary Motion of a Piston"; and "The Effective Area of a Piston." G.G.

**N65-12750#** General Motors Corp., Santa Barbara, Calif. GM Defense Research Labs.
**MILLIMETER RADAR INSTRUMENTATION FOR STUDYING PLASMA EFFECTS ASSOCIATED WITH HYPERSONIC FLIGHT**
H. M. Musal, Jr., R. I. Primich, W. E. Blore, and P. E. Robillard Aug. 1964 18 p refs
(Contracts DA-04-495-ORD-3567(Z); ARPA Order 357-63; Proj. Defender)
(TR64-02J; AD-449823)

Millimeter wavelength radars are being used to study the plasma effects associated with the ionized flow fields of projectiles launched at hypersonic speeds into a free-flight ballistic range. Two cw doppler radars, which operate at frequencies of 35 and 70 Gc, are used to measure the nose-on backscattering radar cross sections of projectiles during their flight. The design and performance of the two radars, which operate simultaneously through a wire-grid beam splitter, are described in detail. A doppler signal simulator provides absolute calibration of each radar so that the dynamic radar cross section of the projectile in flight can be measured to within ± one decibel. The purpose of this millimeter radar instrumentation is to measure the changes that occur in the radar cross sections of hypersonic projectiles caused by their highly ionized flow fields. Author

**N65-12763#** Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
**DETECTOR EFFICIENCY OF CONTINUOUS AIR MONITOR HAVING THE FILTER COAXIAL WITH THE DETECTOR**
E. A. King Oct. 1964 33 p refs
(Contract AT(10-1)-205)
(IDO-17043) OTS: $2.00

The knowledge of the detector efficiency of a continuous air monitor having the filter coaxial with the detector has been related only to Sr-90, Y-90, and radon, thoron daughter products in the past. This paper contains a list of directly determined detector efficiencies for several other radionuclides. It also contains a procedure that can be used by the reader to determine the detector efficiency for additional radionuclides, and was used in this report to extend the list of detector efficiencies versus radionuclides. Author

**N65-12811*#** McGill U., Montreal (Canada).
**PHOTOGRAPHY OF THE WESTERN SAHARA DESERT FROM THE MERCURY MA-4 SPACECRAFT**
A. Morrison and M. C. Chown Washington, NASA, Dec. 1964 132 p refs
(Contract NASr-140)
(NASA-CR-126) OTS Prices: HC $2.75/MF $1.00

The sequence of high oblique color photographs taken by the automatic camera in the MA-4 spacecraft over the western Sahara in 1961 remains the only sequence of generally available photographs recovered from space that shows a land area of near-continental extent not obscured by cloud or haze. The larger geological and landform patterns of the area, as well as vegetation boundaries on the south edge of the Sahara can be mapped from the photographs. One photo illustrates the potentiality of space photography for small-scale land-use mapping. The resolution of the original transparencies in terms of a standard test object was roughly 10 to 15 lines/mm. Observations and calculations show that the smallest ground features that can be seen stereoscopically on these photos are of the order of 1000 ft. high. Much better results could be obtained using a photographic system specifically designed for mapping geographic distributions. Author

**N65-12815*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**DATA ACQUISITION SYSTEM TIME STANDARD. INSTRUCTION MANUAL**
Raymond L. Granata, John U. Thacher, and Paul J. Kushmeider Sep. 1963 159 p
(NASA-TM-X-55112; X-531-63-194) OTS Prices: HC $5.00/MF $1.00

This is a description of the Gilmore Creek data system that provides information concerning vehicles in space and means of acquiring and demoduling the telemetry information transmitted from the vehicle. It contains a timing system that provides the accurate time-of-day information for correlation of the tracking and telemetry data, and supplies synchronized pulses to data-processing equipment. G.G.

**N65-12901#** Air Force Cambridge Research Labs., Bedford, Mass. Solid State Sciences Lab.
**IMPURITIES IN A VACUUM Instrumentation Papers No. 50**
Jerome H. Bloom, Charlotte E. Ludington, and Robert L. Phipps May 1964 25 p refs
(AFCRL-64-377; AD-608433)

The effect and cause of impurities are of great concern to high and ultra-high-vacuum researchers. As most vacuum gages measure only total pressure, a partial pressure analyzer must be used to detect and analyze residual gases. Four types of analyzers are discussed in relation to their operation, useful total and partial pressure ranges, mass range, and advantages. Some effects and causes of impurities are given. Spectra showing some of the various impurities found in vacua are discussed. Author

**N65-12903#** Honeywell, Minneapolis, Minn. Aeronautical Div.
**ALPHA RADIATION HYGROMETER. VOLUME I: AUTOMATIC FROST-POINT HYGROMETER FOR STRATOSPHERIC WATER-VAPOR MEASUREMENTS Final Report, 1 May 1961–15 Jul. 1964**
J. G. Ballinger, L. Kirvida, M. P. Fricke, and J. E. Crowley 15 Aug. 1964 58 p refs
(Contract AF 19(604)-8418)
(AFCRL-64-690 (I); AD-608498)

The mass of the frost deposit on a cooled surface is detected directly by energy attenuation of alpha radiation. An automatic control maintains a constant amount of this frost by controlling the direction of current flow through the thermoelectric cooler. The instrumentation of this hygrometer is described in some detail, and balloon-flight tests of prototype units are presented. Author

**N65-12904#** Honeywell, Minneapolis, Minn. Aeronautical Div.
**ALPHA RADIATION HYGROMETER. VOLUME II: FROST-POINT HYGROMETER:FOR W-47 AIRCRAFT Final Report, 8 Jun. 1962–15 Jul. 1964**
John E. Crowley and Ahmet F. Konar '15 Aug. 1964 101 p refs
(Contract AF 19(604)-8418)
(AFCRL-64-690 (II); AD-608496)

A frost-point hygrometer for use on W-47 aircraft has been designed utilizing alpha-radiation techniques to measure the condensate thickness on cooled surfaces. A study of the problems associated with making frost-point measurements from high-speed aircraft was made as part of the design program. Author

**N65-12905#** Honeywell, Minneapolis, Minn. Aeronautical Div.
**ALPHA RADIATION HYGROMETER. VOLUME III: CURRENT PROBLEMS IN STRATOSPHERIC WATER-VAPOR MEASUREMENTS MADE WITH AUTOMATIC FROST-POINT HYGROMETERS Final Report, 1 Jan. 1963–15 Jul. 1964**
J. G. Ballinger, M. P. Fricke, and R. D. Murphy 15 Aug. 1964 38 p refs
(Contract AF 19(604)-8418)
(AFCRL-64-690 (III); AD-608503)

Instrument inadequacy due to low rates of mass transfer is found to be a highly probable explanation of the current controversy about upper-atmosphere water-vapor content. Another problem is that of contamination of the moist-air sample by water vapor desorbed from the instrument package and vehicle. The magnitude of this effect precludes a simple accommodation of low mass-transfer rates by use of long sampling times. Measures to increase the reliability of future stratospheric data are recommended. Author

**N65-12929#** Thermo-Systems, Inc., Minneapolis, Minn.
**RESEARCH ON THE DEVELOPMENT AND EVALUATION OF A TWO-SENSOR ENTHALPY PROBE**
L. M. Fingerson Wright-Patterson AFB, Ohio, ARL, Oct. 1964 67 p refs
(Contract AF 33(657)-9917)
(ARL-64-161; AD-608605)

The applicability of measuring plasma enthalpies with an immersion probe using two miniature heat-flux transducers is investigated both analytically and experimentally. The transducers considered were 0.006-in. o.d. internally cooled insulating tubes with a platinum resistive film on the surface. The two-sensor technique involves making heat-flux measurements to two identical bodies operating at different surface temperatures. The problem of survival in the plasma environment and the accuracy requirements for two-sensor measurements are investigated. Miniature sensor supports are tested in an argon plasma. A heat-flux traverse of an oxygen–acetylene torch with a sensor is presented, along with some two-sensor measurements in environments under 1600° F. Author

**N65-12942#** Phillips Petroleum Co., Idaho Falls, Idaho.
**PRELIMINARY STUDIES FOR A CURVED-CRYSTAL NEUTRON SPECTROMETER**
R. R. Spencer, L. G. Miller, and M. S. Moore Oct. 1964 26 p refs
(Contract AT(10-1)-205)
(IDO-17022)

Preliminary studies of the diffraction properties of both plane and curved crystals of various materials have been carried out, pursuant to their application as monochromators in a curved-crystal neutron spectrometer. Most promising of the crystals studied were a flat germanium crystal, a curved NaCl crystal, and a curved beryllium crystal. Author

**N65-13007#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**MARCH TOWARD ULTRA-HIGH VACUUM**
Lin Ting 30 Oct. 1964 9 p Transl. into ENGLISH from K'o Hsueh Ta Chung (China), no. 9, 1963 p 14–15
(FTD-TT-64-608/1+2+3+4; AD-608180)

The history of the development and attainment of increasingly higher vacuums is described in general observations. The achievement of high and ultra-high vacuums is reported and the difficulties of maintaining such vacuums are observed. The phenomena peculiar to ultra-high vacuums as well as problems of measuring vacuums are discussed. G.G.

**N65-13061#** Aerojet-General Corp., Sacramento, Calif.
**DEFLECTION TRANSMISSION CABLES FOR USE IN THERMAL ENVIRONMENTS IN EXCESS OF 3500° F Final Report, 1 Jul. 1963–31 May 1964**
Allen T. Green and Richard K. Steele Wright-Patterson AFB, Ohio, AF Flight Dyn. Lab., Oct. 1964 82 p refs
(Contract AF 33(657)-11354)
(FDL-TDR-64-69; AD-608472)

A method of transmitting deflections from a test structure at 3500° F to a transducer at room temperature was developed. During high-temperature structural tests, accurate test-specimen deflections can be determined only by use of a test specimen-to-transducer link in which thermal expansion and creep are minimal or accountable. The deflection-transmission-cable link developed consists of water-cooled Invar tubes in an assembly that is spring-loaded to contact the test specimen through a replaceable polycrystalline alumina ceramic tip (Lucalox). The deflection link was evaluated under static and quasi-static test-specimen heating rates and specimen temperatures to 3500° F and a 1/2-hr exposure time. Coefficients of thermal expansion and creep tests were measured at elevated temperatures on each material. The deflection-transmission link is capable of transmitting test-specimen motions of 4 in. or less with an accuracy of 0.5% of full scale. Author

**N65-13080#** Raytheon Co., Burlington, Mass. Spencer Lab.
**PHOTOELECTRIC MILLIMETER WAVE DETECTOR Final Report**
G. F. Giggey, P. P. Debye, and P. R. Bratt Griffiss AFB, N.Y., RADC, Oct. 1964 63 p refs
(Contract AF 30(602)-3015)
(RADC-TDR-64-292; AD-608710)

In furthering the application of semiconductor materials as photoconductive detectors of millimeter and submillimeter wavelength radiation, studies were continued on indium antimonide in a magnetic field and at very low temperatures. A definite relationship was established between the initial properties of the material and the amount of magnetic field required to obtain highest detectivity. The sample preparation technique that resulted in the highest detector performance was to etch the contact surface of the detector and to lightly grind the other surfaces with a slurry of aluminum oxide powder. The detector response was measured at 250 nanoseconds for both the InSb-1 and InSb-2 materials. Other semiconductor materials, such as germanium, indium arsenide, and gallium arsenide, were also investigated. Some samples of gallium arsenide were found to be highly sensitive to millimeter radiation of 2- and 4-mm wavelength. A sample of antimony-doped germanium was tested unstrained and found to be sensitive in the submillimeter wave region. An experimental model of a detector using indium antimonide and capable of detecting wavelengths at least as long as 4 mm was constructed. A breadboard model of a photoconductive detector using gallium arsenide and capable of detecting wavelengths longer than 0.1 mm was also constructed. R.L.K.

**N65-13090#** Cutler-Hammer, Inc., Deer Park, N.Y. Airborne Instruments Lab.
**SOLID-STATE FERROELECTRIC ACCELEROMETER Interim Report, 4 May–4 Aug. 1964**
S. H. Gross and A. Hebling 11 Sep. 1964 33 p refs
(Contract NOw-64-0093-c)
(IR-3; AD-449377)

Two methods of investigating the ferroelectric crystal $BaTiO_3$ did not give reproducible results, so emphasis was shifted to investigations of plastic ferroelastic materials (urethane rubbers), which appear promising for providing the desired high resolution. Tension, compression, and bending test methods were evaluated, and it was found that the pure tension method gave the most consistent and reliable results. In a search for suitable ferroelectric materials, the relative properties of candidate materials are being theoretically assessed, and a literature search for experimental data on these materials is being conducted. M.P.G.

**N65-13120#** College of Aeronautics, Cranfield (Gt. Brit.)
**A HIGH SPEED INCREMENTAL ANALOGUE-DIGITAL CONVERTER**
D. E. Hyndman, H. B. Gatland, and R. J. A. Paul Aug. 1964 15 p refs
(CoA-E&C-4)

This report describes the design and performance of a high speed incremental analog–digital converter based on delta modulation techniques described previously. The converter operates with a clock rate of 1 Mc/sec, resulting in an incremental conversion rate of 1 μsec. The design, accuracy requirements, and circuits of the basic units are described. Author

**N65-13129#** Houston Fearless Corp., Los Angeles, Calif. Westwood Div.
**COLOR IMAGE-ENHANCEMENT PROGRAM Final Report**
Paul De Coster and Norman Taylor Bedford, Mass., AFSC, Electron. Systems Div., Jul. 1964 84 p ref
(Contract AF 19(628)-416)
(R-130-64; ESD-TDR-64-521; AD-608277)

The feasibility of applying color in enhancing the image of a photograph for information extraction is investigated. Producing a new and improved image of the original photograph is not limited to a faithful reproduction of the original scene. The original photograph is in black and white, and the color is introduced synthetically to reveal previously obscured information. The theory of image enhancement is discussed, and the design and fabrication of equipment to test and evaluate electronic and optical concepts is described in detail. D.S.G.

N65-13141*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**DESIGN FOR A SPACE MOLECULAR SINK SIMULATOR**
J. B. Stephens and D. A. Wallace 15 Nov. 1964 27 p refs
(Contract NAS7-100)
(NASA-CR-59831; JPL-TR-32-688) OTS Prices: HC $2.00/MF $0.50

The results of a design study for a space molecular-sink vacuum-system facility are presented. The sharp-V-grooved, $LN_2$-cooled, molecular trap shrouds are a capture improvement of an order of magnitude over smooth walls and capture 99.96% of the condensable molecules emanating from the test item before they can return. A non-flaking, Dewar-fed, 20° K helium cryopump is used to remove all gases noncondensable at 77° K except helium and hydrogen. Ion pumps operating at 77° K, in conjunction with titanium sublimation onto the molecular trap shrouds, remove the two remaining gases. A 270-cfm pump (operating in the viscous-flow regime) and a 140 liter/sec turbomolecular impact pump are used to rough-pump the double-walled, double-doored, bottom-loading vacuum chamber, 10 feet in diameter, and to sustain the guard vacuum. The chamber is decontaminated, and titanium evaporant is removed by 250° C vacuum bake-out in conjunction with glass-bead blasting. Contaminant-free loading, pump-down, sustained ultrahigh-vacuum operation, backfill, and unloading techniques are described. Author

N65-13176# Oak Ridge Inst. of Nuclear Studies, Inc., Tenn.
**BLUEPRINTS OF AN AUTOMATIC ZONAL SCRAPER AND SAMPLE COLLECTOR FOR RADIOASSAY OF THIN-LAYER CHROMATOGRAMS**
Fred Snyder and Harry Kimble Nov. 1964 11 p refs
(Contract AT(40-1)-GEN-33)
(ORINS-47) OTS: $1.00

A specially designed manual scraper for zonal radioscanning of thin-layer chromatoplates served as a prototype for the construction of a completely automatic zonal scraper and sample collector. Liquid scintillation counting of the zones provides $4\pi$ counting geometry and efficiencies comparable to those observed for nonquenched liquid systems containing carbon-14 and tritium. Plotting the radioactivity of each adjacent zone as a continuum results in the distribution of activity according to its position on the thin-layer chromatography plate. A description of the operation of the automatic scraper and sample collector is presented together with photographs and blueprint drawings. D.S.G.

N65-13292# Ampex Corp., Redwood City, Calif.
**APPLIED RESEARCH ON HIGH RESOLUTION FILM SCANNING Sixth Quarterly Interim Report, 1 May–1 Nov. 1964**
D. Orme and K. F. Wallace 24 Nov. 1964 60 p refs
(Contract AF 33(657)-11091)
(RB-64-48; AD-452919)

The construction, testing, and purchasing of equipment for the scanner have advanced to the point at which assembly of the main unit can be started. The principal components of the auxiliary unit (roughing pump and air compressor) have been received. There was a significant improvement in the design and operation of the electron gun. The grid–cathode structure was modified for greater mechanical stability, and it was shown that filament life can be substantially increased by constant-voltage operation. These two features should considerably simplify one of the more difficult operating procedures—filament replacement and subsequent realignment of the electron optics. The film transport has been assembled, and preliminary tests were made. The motor control circuitry is built and ready for testing. Except for the video amplifier, filament power supply, and correction waveform synthesizers, the electronic equipment has been built and partially tested. Author

N65-13313*# California U., Berkeley. Space Sciences Lab.
**DYNAMIC PERFORMANCE OF PRESSURE TRANSDUCERS IN SHOCK AND DETONATION TUBES**
William E. Amend, A. J. Laderman, and A. K. Oppenheim Sep. 1964 114 p refs
(Contract NAS8-2634; Grant AF-AFOSR-129-64)
(SSL-TN-9; IER-64-13; AD-607381) OTS: $5.00

A method is presented for evaluating the dynamic performance of high-frequency pressure transducers on the basis of records obtained by means of shock tube calibration tests. Under the assumption that the transducer behaves as a linear system, with an arbitrary number of degrees of freedom, its frequency response is determined from a Fourier transform analysis. The computations have been programed for the IBM-7090 computer including provision for the use on the cal-comp plotter to produce results describing the frequency dependence of the amplitude ratio, phase-angle shift, and time lead between the output and input signal. Performance characteristics have been calculated for several typical transducers, demonstrating the utility of the method in delineating frequency regimes where reliable response of the instrument can be expected. An assessment has been made of the influence of common types of errors, introduced in the input data, on the calculated response. Author

N65-13335# General Motors Corp., Anderson, Ind. Delco-Remy Div.
**FEASIBILITY STUDIES OF THE ELECTROTHERMALLY REGENERATIVE TRANSDUCER Final Report, Part II**
Robert D. Weaver 30 Jun. 1964 91 p
(Contract DA-33-008-ORD-2335(T))
(AD-607293) OTS: $4.00

Laboratory cells, utilizing sodium and chlorine as reactants, have been assembled and tested. They were shown to produce theoretical voltages over a temperature range of 825° to 1219° C and were capable of being discharged at more than 20 amperes per square inch of electrode area. They were charged and discharged and exhibited electrochemical reversibility. Studies of protective coatings for cell container materials were made. A cell of more advanced design leading toward a prototype cell was engineered, assembled, and tested. This work is evaluated in terms of practical feasibility of the electrothermally regenerative transducer and a fuel cell battery based on the alkali metals and the halogens as reactants. Author

# 15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

**N65-12335*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**EVALUATION OF STRAIN INDICATOR COATINGS FOR APPLICATION IN DETECTING VOIDS IN BONDED HONEYCOMB SANDWICH STRUCTURES**
Paul H. Schuerer and William G. Simpson 21 Sep. 1964 24 p
NASA-TM-X-53155) OTS Prices: HC $1.00/MF $0.50

A new concept for manufacturing process control of honeycomb sandwich structures has been successfully demonstrated. Two strain indicator coatings, a brittle lacquer and a photoelastic plastic, were evaluated and proved adequate for detecting unbonded areas in bonded honeycomb sandwich panels. The ease with which the coatings can be applied indicates the potential usage of this void detection technique for larger, more complex surfaces. Author

**N65-12415*#** IIT Research Inst., Chicago, Ill. Technology Center
**INVESTIGATION OF SLIP-RING ASSEMBLIES Quarterly Report No. 6, 5 Aug.–5 Nov. 1964**
[1964] 16 p
(Contract NAS8-5251)
(NASA-CR-59710; E-6000-18) OTS Prices: HC $1.00/MF $0.50

The spectrographic analyses of wear debris conducted thus far have indicated that the primary constituent is gold from the ring surface. Some evidence of a minor hydrocarbon component has been obtained. Run-in tests of experimental capsules have demonstrated that surface lubrication is particularly effective in maintaining low noise levels and in minimizing wear of the ring and brush surfaces. A run-in test of a commercial capsule has indicated that there is a significant difference in the nature of the wear deposit that is accumulated during run-in. Experiments with various rhodium-modified gold plating baths have indicated that the hardness of the plate decreases as the concentration of rhodium ions increases. Author

**N65-12419*#** Sherwin-Williams Co., Chicago, Ill. Chicago Lacquer Lab.
**DEVELOPMENT OF CORROSION INHIBITING WHITE PRIMER Final Report, 26 Jun.–30 Nov. 1964**
Paul Schnake, Derwood P. Jensen, and Robert H. Albrecht [1964] 7 p
(Contract NAS8-11788)
(NASA-CR-59665) OTS Prices: HC $1.00/MF $0.50

Studies were conducted to develop a corrosion-resisting white primer. In the development of this primer, the effects of pigments and vehicles were evaluated. A vehicle based on a safflower RJ100 urethane varnish was found to contribute superior corrosion resistance, largely without deleterious effects on other film properties. A combination of titanium dioxide and zinc molybdate pigments was found to contribute to a maximum in hiding and corrosion resistance. Various cleaning and metal-treatment methods, as well as various film thicknesses of the primer, were evaluated to achieve maximum metal protection at a minimum primer weight. Author

**N65-12436#** Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
**DEVELOPMENT OF A NONDESTRUCTIVE INSPECTION METHOD FOR TITANIUM WELDMENTS Final Report**
H. H. Spieth and A. D. Warren 7 Aug. 1964 120 p refs
(Contract N-140(131)75808B)
(SM-44667)

The program to develop a nondestructive inspection method for titanium weldments is presented. The most successful method developed was neutron activation analysis for oxygen and carbon detection. A vacuum hot extraction method using an electron-beam welder successfully differentiated uniformly contaminated screening specimens, but was unable to detect single contaminated passes in a 2-in. weldment. The electron-beam spike apparently damaged the weld as well. Temperature coefficient of resistance and ultrasonics inspection methods were eliminated after the screening phase of the program. Author

**N65-12440*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**THE KINETICS OF THE SINTERING OF HOT PRESSED MOLYBDENUM DISULFIDE AND MOLYBDENUM DISULFIDE-SILVER COMPOSITIONS AND THE EFFECT ON THE ELECTRICAL CONDUCTION PROCESSES**
Donald R. Ulrich and Harry M. King 19 Aug. 1964 22 p refs
(NASA-TM-X-53111) OTS Prices: HC $1.00/MF $0.50

The hot-pressing kinetics of molybdenum disulfide and molybdenum disulfide-silver compositions, which are of interest as electrical conductors in a vacuum, have been studied. The rate of sintering is described by the first-order rate equation of Murray et al. as being a molybdenum-disulfide-controlled plastic flow mechanism. The diffusion of silver is a second process occurring over the temperature range of hot pressing. The electrical-conduction mechanism as a function of both composition and fabrication temperature is discussed. Author

**N65-12458#** Materials Research Corp., Orangeburg, N.Y.
**CRYOGENIC LIQUID TRANSFER TECHNIQUES Technical Documentary Report, 1 Apr. 1963–1 Apr. 1964**
D. Ben-Israel and L. Skala Wright-Patterson AFB, Ohio. AF Avionics Lab. [1964] 37 p refs
(Contract AF 33(657)-10920)
(AL-TDR-64-126; AD-606496)

Applied research was carried out on the cooling of infrared radiation detector cells. In particular, problems associated with the insulation and transfer of cryogenic liquids were studied. A vapor-shielded vacuum-insulated closed-loop transfer line was suggested as an optimum system for increased transfer efficiency. A new superinsulation material based on silverized quartz fibers was developed and incorporated in transfer lines. Various aspects of the technical applications of these developments are described and critically discussed. Author

**N65-12517#** Motorola, Inc., Phoenix, Ariz. Semiconductor Products Div.
**NON-VACUUM DEPOSITION TECHNIQUES FOR USE IN FABRICATING THIN FILM CIRCUITS Interim Engineering Report No. 1, 1 Jul.–30 Sep. 1964**
15 Oct. 1964 50 p refs
(Contract NObsr-91336)
(AD-450131)

Methods for the vapor phase deposition of a variety of metal-oxide-based dielectrics have been developed. A general purpose apparatus for the deposition of these materials has been developed and is described. Preliminary evaluation of vapor deposited, $SiO_2$, $Ta_2O_5$, $Al_2O_3$, $(Al_2O_3)_A \cdot (SiO_2)_B$, and $(Al_2O_3)_A(SiO_2)_B(B_2O_3)_C$ dielectrics is reported. Tin oxide resistors have been deposited by a vapor phase reaction of tetraethyl tin and oxygen using the apparatus developed for the deposition of dielectric films. Films of tin oxide doped with antimony and aluminum oxides have been deposited and evaluated. Thin film resistors of doped tin oxide show a gain in

stability and a reduction in temperature coefficient of resistance when encapsulated with a vapor-plated dielectric film. Author

**N65-12527#** Goodyear Tire and Rubber Co., Akron, Ohio.
**PROPELLANT ADHESIVES RESEARCH First Quarterly Report, 1 Feb.–21 Apr. 1964**
H. M. Rice 22 Jun. 1964 27 p refs Sponsored by Hercules Powder Co.
(Rept.-19-396; AD-449954)

Theoretical studies and laboratory experimentation led to the selection of a stable organic liquid that appears to have solvating characteristics similar to those of the casting solvent used in the manufacture of double-base propellants. The reactions of 59 potential adhesives with this liquid were noted. Five of these potential adhesives showed appreciable swelling but good strength retention in the presence of the test liquid. Author

**N65-12530#** General Electric Co., Schenectady, N.Y. Research Lab.
**PREPARATION TECHNIQUES FOR GROWTH OF SINGLE CRYSTALS OF NONMETALLIC MATERIALS Final Report, 1 Jun. 1963–31 May 1964**
E. M. Clausen and J. W. Rutter Jun. 1964 32 p refs
(Contract AF 49(638)-1247)
(Rept.-64-GC-0279M; AD-602945) OTS: $2.00

This report describes two techniques for growth of high-purity single crystals of nonmetallic materials using rf induction-heating equipment in a frequency range of 5 to 100 Mc. One technique used for single-crystal growth was the Verneuil method, using an induction-coupled plasma as a heat source instead of the conventional mixture of combustible gases. Materials that were melted in the plasma include $Al_2O_3$, $CoAl_2O_4$, NiO, $Eu_2O_3$-doped $Y_2O_3$, $TiO_2$, CaO-stabilized $ZrO_2$, $MgAl_2O_4$, and MgO. Single crystals of $CoAl_2O_4$ were grown. The second crystal growth technique investigated was floating-zone melting using rf induction heating. Materials that were directly rf coupled and subsequently heated include NiO, $TiO_2$, $BaTiO_3$, CaO-stabilized $ZrO_2$, $CoFe_2O_4$, and yttrium iron garnet (YIG). Molten zones were traversed through polycrystalline rods of $CoFe_2O_4$, YIG, and NiO, with the majority of the work concentrated on NiO. Author

**N65-12567#** Thompson Ramo Wooldridge, Inc., Cleveland, Ohio. TRW Structures Div.
**DEVELOPMENT OF NONDESTRUCTIVE TESTING TECHNIQUES FOR LARGE SOLID ROCKET NOZZLES First Quarterly Progress Report, 11 Jun.–30 Sep. 1964**
[1964] 79 p refs
(Contract AF 04(611)-9972)
(ER-5875-4; RPL-TDR-64-128; AD-451355)

A literature search was conducted on NDT techniques applied particularly to large solid rocket nozzles. An engineering analysis for the development of a preliminary acceptance criteria was initiated. A preliminary classification of defects according to their apparent influence upon nozzle performance is presented. The influence of a delamination upon the stress field in an exit cone is discussed. Computer programs were designed to investigate radiographic ray tracing and the effect of various impurity geometries and materials on the temperature distributions in an ablating plastic structure. The design of test specimens with known defects is presented. Author

**N65-12578#** NRC Equipment Corp., Newton, Mass.
**DIFFUSION PUMP BAFFLE STUDY Technical Documentary Report, 30 Jul. 1962–20 Apr. 1964**
M. H. Hablanian Arnold AF Sta., Tenn., Arnold Eng. Develop. Center, Nov. 1964 70 p refs
(Contract AF 40(600)-1009)
(AEDC-TDR-64-253; AD-451427)

This study was undertaken to develop and test a diffusion pumping station having maximum pumping speed consistent with minimum backstreaming for use on a large space environmental chamber. The complete system includes pump, duct, and baffle. Conductance measurements were made using small-scale model ducts and baffles to determine the most promising configuration for the full-scale system. As a result of this preliminary work, a 52-in.-diam, liquid-nitrogen-cooled baffle was developed that has a transmission probability of 0.35 whereas the reducer duct–baffle combination developed retains 50% of the pumping speed above the baffle. Backstreaming measurements ranged from $7.3 \times 10^{-7}$ mg/cm$^2$-min for a short duration test (63 hours) to $7 \times 10^{-8}$ mg/cm$^2$-min for a long duration test (524 hours). Along with the backstreaming measurements, the residual gas composition in the test dome was checked with a mass spectrometer residual gas analyzer. Comparison of the backstreaming rates of two diffusion pump oils above a liquid-nitrogen-cooled baffle was made. The baffle was constructed to approximate the full-scale 52-in.-baffle. The DC-705 had a slightly higher backstreaming rate than Convalex 10, but somewhat lower ultimate pressures were obtained with the DC-705. Author

**N65-12592#** Naval Ordnance Lab., White Oak, Md.
**THE WINDING AND CURING OF LARGE REINFORCED PLASTICS STRUCTURES**
Marlin A. Kinna and Robert W. Warfield Dec. 1964 25 p refs
(NOLTR-64-162; AD-451073)

This report contains data and test results leading to the development of a technique for monitoring the cure of large plastic structures. The technique makes use of a continuous current monitoring device (CCMD) to follow the cure. The results of this study showed that CCMD techniques are feasible when applied to large, continuous fiber-reinforced plastic composite structures. In addition, it was demonstrated that the fabrication of large structures, complete with cure monitoring cells as required, can be carried out without difficulty. Author

**N65-12614*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**QUALITY CONTROL AND NONDESTRUCTIVE TESTING FOR THE PREVENTION OF FAILURES IN SCIENTIFIC SATELLITES**
Alfred J. Babecki [1963] 35 p Presented at the 6th Natl. SAMPE Symp., Seattle, 18–20 Nov. 1963
(NASA-TM-X-54876) OTS Prices: HC $1.00/MF $0.50

This quality improvement program proposes the early and continued use of qualified materials experts, and the establishment of materials and process standards and specifications, in order to eliminate poor workmanship and improper materials selection. G.G.

**N65-12639#** General Electric Co. Owensboro, Ky. Tube Dept.
**DEVELOPMENT OF AN IMPROVED JAN 6299 Final Report, 1 May 1961–30 Jun. 1964**
D. L. Cook [1964] 235 p
(Contract DA-36-039-SC-85953)
(AD-606324)

Advanced tube-manufacturing techniques were evaluated and applied, where feasible, to JAN 6299. Results obtained in improved alignment and concentricity studies, in optimization of cathode coating, and in improved exhaust fixturing are now being applied to regular production tubes. Best results during humidity tests were obtained by improving plating techniques and controls to minimize metal-shell corrosion. The improved tubes exhibited superior life-test results at an anode seal temperature of 225°C. The inverted cathode supporting-ring mounting resulted in cathode subassemblies with better uniformity and increased ruggedness. A temperature controller was developed that decreases the operator skill necessary to perform uniform exhaust cycles. Extended life test of the improved tube has completed 1795 hours. M.P.G.

**N65-12650#** Iowa State U. of Science and Tech., Ames. Ames Lab.
**DESIGN AND OPERATION OF A FLAT LINEAR INDUCTION PUMP**
Delwyn Donald Bluhm, R. W. Fisher, and J. W. Nilsson Jul. 1964 84 p refs
(Contract W-7405-ENG-82)
(IS-991)

A five-pole, one slot per phase, full-pitch, twelve-coil, wye connected, three-phase linear induction pump was designed for operation with 400°C sodium. The design incorporated a graded winding in order to reduce the net pulsating component of the magnetic flux density wave and a pump duct using copper side bars. The small laboratory-size pump was designed in two steps: stator design and winding design. The theoretical performance characteristics of the flat induction pump were computed using the equivalent circuit parameters for a winding with 60 turns per coil. The measurement of developed pressure (0 to 42.13 psi), sodium flow rate (0 to 9.93 gpm), and power input (0 to 103.9 watts), after installation of the pump in an operational sodium circulating loop, provided an experimental determination of the pump performance characteristic. In addition, the effect of pump duct temperature on sodium flow rate and a differential transformer system used to locate the sodium level in manometer columns were briefly discussed. Author

**N65-12680#** General Dynamics/Electro Dynamic, Avenel, N.J.
**HIGH ENERGY IMPACT FORMING PROGRAM: PROTOTYPE MACHINE DESIGN, TOOLING DESIGN AND TEST PROGRAM, PHASE IV 1 Aug. 1962–31 May 1964**
Frank A. Stratton Wright-Patterson AFB, Ohio, ASD, May 1964 68 p
(Contract AF 33(600)-43035)
(ASD-TR-7-848(IV); AD-449699)

The prototype high-energy rate, rubber-pad, sheet-metal forming machine was designed, detailed, and checked. Procedures were determined and evaluated for checking the rubber-pad pressures at impact and the ram relative velocity at impact. Tool design and fabrication was completed. Materials to be tested were selected and the material test program was prepared. Author

**N65-12726#** Rock Island Arsenal Lab., Ill.
**THE DEVELOPMENT OF TRANSPARENT COMPOSITE PACKAGING MATERIALS**
L. W. Lynch 30 Jul. 1964 16 p refs
(Rept.-64-2362; AD-449741) OTS: $0.50

Seven transparent composite plastic films have been prepared by industry for evaluation as replacements for presently accepted (MIL-B-131 and MIL-F-22191A) packaging materials. The composite films, along with qualified barriers, were tested according to specified procedures and requirements. The two best films, (1) a composite of fluorocarbon (1/2 mil) and oriented polypropylene (1 mil), and (2) a composite of fluorocarbon (1/2 mil) and mixed polyethylene and polyester (2-1/2 mil) were found to be equivalent in properties to presently qualified products (of MIL-F-22191A). The fluorocarbon–polypropylene composite was found to be superior in most respects to currently used opaque packaging materials (MIL-B-131 type). The two best composites were priced below currently qualified films but above presently used materials. P.V.E.

**N65-12756#** Frankford Arsenal, Philadelphia, Pa.
**MANUFACTURE OF URANIUM-8.5% MOLYBDENUM BALLS**
R. V. London and R. E. Edelman Jul. 1964 16 p refs
(M65-3-1; AD-448999)

In an effort to meet increasing demands by the Army for components fabricated from dense materials (such as an 0.20-in.-diam ball weighing 20 ±1 gr), a study was made to find suitable material and methods of processing. Of the two materials (uranium- and tungsten-based alloys) having the necessary density, a uranium–8.5% molybdenum alloy was chosen because of its combination of strength and ductility. The problem of fabricating a smooth wire, free from kinks and surface imperfections, was undertaken, and the various phases of the process—casting, heat treating, forging, rolling, annealing, swaging, and testing—are described. Author

**N65-12810*#** Debell and Richardson, Inc., Hazardville, Conn.
**STUDIES OF HOLLOW MULTIPARTITIONED CERAMIC STRUCTURES**
William J. Eakins and Richard A. Humphrey Washington, NASA, Dec. 1964 76 p refs
(Contract NASw-672)
(NASA-CR-142) OTS Prices: HC $3.00/MF $0.75

Results are presented of a 15-month program of forming glass filaments whose shape is other than a solid round. The feasibility of drawing precise geometric shapes of fibers is demonstrated. With the objective of high stiffness-to-weight ratio, most of the fibers were drawn into hollow cross sections of various shapes for subsequent filament winding. Of particular interest are hollow hexagonal, triangular, and rectangular filaments. Surprisingly complex hollow fibers can also be drawn by the highly refined preform attenuation process used in this program. Author

**N65-12845#** Stencel Aero Engineering Corp., Asheville, N.C.
**A4D-MS-UPP ESCAPE SYSTEM: HARDWARE DEVELOPMENT Final Engineering Report, 16 Apr. 1962–30 Jun. 1964**
R. Wiley et al [1964] 71 p
(Contract NOw-62-0587-c)
(Rept.-62-30-005; AD-449922)

A prototype hardware and equipment design, development, and fabrication program was undertaken to arrive at elements adaptable for use in the T2J and A4D ejection-seat escape systems. A change of specifications provided for inclusion of the LS-1 UPP (ballistic parachute), a cool gas generator for pararaft inflation, ballistically actuated takeup reels on the restraint harness, and a ballistic parachute-canopy release actuator. Flight-testing the system verified its reliability and proper operation of the time-sequencing train. Recommendations are made for a follow-on study program to optimize overall system performance. Author

**N65-12847#** United Aircraft Corp., East Hartford, Conn. Research Labs.
**EXPLORATORY INVESTIGATION OF GLASS-METAL COMPOSITE FIBERS Bimonthly Progress Report No. 2, 14 Jun.–13 Aug. 1964**
John E. Cox, Richard D. Veltri, and Charles E. Shulze 11 Sep. 1964 30 p
,Contract NOw-64-0389-f)
(C910242-2; AD-609117)

Investigations have been made to develop a technique for introducing molten beryllium into a glass capillary as the glass is being pulled from tubing to fiber. Beryllium oxide, beryllium oxide-coated graphite, and boron nitride appeared to be satisfactory crucible materials for molten beryllium. Controlled flow of the metal from the crucible through an orifice has been complicated by a protective oxide coating that forms on the metal particles during heating. Research on a process for copper filaments was concerned with an apparatus for determining the continuity of the copper core as the copper–glass composites are being drawn. Work on chromium-in-silica composite fibers was continued with a high-temperature resistance furnace. Author

**N65-12848*#** Martin Co., Baltimore, Md.
**[FABRICATION OF HELIUM STORAGE BOTTLES] Third Quarterly Progress Report, May–Jul. 1964**
[1964] 3 p
(Contract NAS8-11555)
(NASA-CR-59781) OTS Prices: HC $1.00/MF $0.50

The forming and internal machining of 10 helium storage-bottle units was completed. Shot-peening and heat-treating operations were performed on all units, and production acceptance tests were started. G.G.

**N65-12849#** Western Electric Co., Inc., Laureldale, Pa.
**PRODUCTION ENGINEERING MEASURE: MECHANIZATION OF SEMICONDUCTOR DEVICES, 2N559–2N1094 Quarterly Progress Report, 1 Jan.–31 Mar. 1964**
M. N. Reppert [1964] 41 p
(Contract DA-36-039-SC-72729)
(QPR-25; AD-602005)

A pre-evaporation bake was instituted to clean the slice surface and to inhibit base stripe balling. Furnace alloying of stripes is being evaluated, along with potential refinements in germanium-slice diffusion. Collected data indicate that an automatic furnace boat programer is an effective aid in controlling diffusion processes. Tests have shown that the use of a developmental assembly to etch silicon as well as germanium devices is feasible. Other areas of work discussed include wire bonding, stripe evaporation and alloying, header thermal capability, material handling, emitter etching, silicon dioxide coating, and header internal-lead trimming. P.V.E.

**N65-12954#** Joint Publications Research Service, Washington, D.C.
**INDUSTRIAL SAFETY IN WORK WITH BERYLLIUM AND ITS ALLOYS**
I. A. Akopov et al 23 Dec. 1964 112 p refs Transl. into ENGLISH of the book "Bezopasnost' Truda pri Rabote s Berilliyem i Yego Splavami" Moscow, 1964 p 1–107
(JPRS-27-976; TT-64-51994) OTS: $4.00

The book presents the physical and chemical properties of beryllium and its alloys; their toxicity, characteristics of casting, rolling, mechanical treatment, and welding are described. A classification of operations with respect to toxicity is presented, and the requirements for safety techniques are discussed. Great attention is paid to labor hygiene in various processes of beryllium production and the treatment of alloys containing beryllium. In connection with the wide use of the cast alloys VAL 2, AL8U, and others in industry, concrete data are presented on the characteristics of working conditions during their production and processing. Author

**N65-12955#** Joint Publications Research Service, Washington, D.C.
**SAFETY ENGINEERING IN WORKING WITH BERYLLIUM**
I. Ya. Yukhim' 24 Dec. 1964 8 p refs Transl. into ENGLISH from Metalloved. i Term. Obrabotka Metal. (Moscow), no. 11, Nov. 1964 p 39–41
(JPRS-27-980; TT-64-51996) OTS: $1.00

The safety measures applied in the handling of beryllium and its compounds are determined by the source of toxicity that they help prevent. Although the soluble compounds of beryllium are more toxic to man, the danger of beryllium and its insoluble compounds penetrating into the respiratory organs in the form of finely dispersed aerosols is quite substantial. Acute poisoning symptoms from exposure to beryllium range from fever-elevated temperatures, severe coughing, dyspnea, pain, hoarseness, and lung inflammation, to ulcers on the skin. Industrial safety measures, including servicing the equipment that comes in contact with beryllium and the special sanitary-hygienic precautions for workers and their environment, are discussed. G.G.

**N65-13021#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ROENTGENOGRAPHY**
G. F. Kosolapov 31 Aug. 1964 312 p refs Transl. into ENGLISH of the book "Rentgenografiya" Moscow, Gos. Izd. "Vysshaya Shkola," 1962 p 1–332
(FTD-MT-63-261; AD-608076)

This is a training manual for students specializing in metallurgy and the heat treatment of metals. Sections are included on the spectra of X-rays, equipment used in X-ray analysis, elements of crystallography, interference of X-rays, fundamental methods of investigation of structure, the study of phase diagrams of alloys by X-ray analysis, the structure of plastically deformed and recrystallized metal, the determination of residual stresses by X-ray methods, X-ray analysis of heat-treated steel, X-ray analysis of supersaturated solid solutions, X-ray analysis of the structure of liquid metals, X-ray flaw detection, and electron and neutron diffraction. D.E.W.

**N65-13022#** Metals and Controls, Inc., Attleboro, Mass.
**DEVELOPMENT OF OPTIMUM PROCESSING PARAMETERS FOR REFRACTORY METAL FOIL Second Technical Documentary Report, 1 May 1963–31 Mar. 1964**
J. J. Buchinski, G. P. Trost, and P. A. Dion Jun. 1964 177 p refs
(Contract AF 33(657)-9384)
(ASD-TDR-63-829, Pt. II; AD-607683)

Approximately 480 pounds of high-quality 2-, 6-, and 12-mil B-66, Cb-752, D-43, and T-111 alloy strip were produced and extensively evaluated. Recommendation for processing and quality assurance procedures for the production of high-quality refractory metal foil were prepared. Rollability studies of program alloys were conducted on an instrumented laboratory rolling mill. Flatness correction for 6-mil foil

through the use of the roller-stretching principle was demonstrated. Work-hardening and recrystallization characteristics of the foil materials were determined. A special study of the B-66 cracking problem was conducted. Author

**N65-13033#** Aeroprojects, Inc., West Chester, Pa.
**ULTRASONIC WELDING PROCESS AND EQUIPMENT FOR CONSTRUCTION OF ELECTRON-TUBE MOUNTS Quarterly Progress Report, 1 Jan.–31 Mar. 1964**
J. G. Thomas [1964] 13 p
(Contract DA-36-039-SC-86741)
(QPR-7; AD-608177)

Ultrasonic welding of the electron tube mount for tube type 6080WB was evaluated. Prior experience in welding leads to glass–metal assemblies indicated that the temper of the glass material had an effect on the quality of the seal. Ultrasonic welds were made between connectors and stem leads for three different tempers of glass in the stem assemblies; no fracturing occurred. In addition, the quality of the welds, the ease with which they were effected, the simplicity of the tool change, and the absence of spatter and oxidation resulting from the welding were noted as satisfactory. The problem of carbon anode breakage during tube manufacture were eliminated using ultrasonic activation. D.S.G.

**N65-13039#** Nuclear Metals, Inc., Concord, Mass.
**DEVELOPMENT OF DIES FOR EXTRUSION OF COMPLEX SHAPES OF STEEL AND REFRACTORY ALLOYS Final Report, Jul. 1962–30 Jun. 1964**
J. G. Hunt, J. L. Klein, and J. M. Siergiej Wright-Patterson AFB, Ohio, AF Mater. Lab., 25 Nov. 1964 138 p refs
(Contract AF 33(657)-8798)
(ML-TDR-64-295; AD-608497)

Precision extrusion of shaped structural steels through ceramic-coated dies was gained by refinement and close control of extrusion parameters. Refractory ceramics of high compression strength like $ZrO_2$ or TiC were found capable of extruding TZM molybdenum alloy at 3700° F and 75 tsi producing 2.0 by 1.3 by 0.250-in. Tee sections in lengths up to at least 14 ft with dimensional runout of less than 3 mils and surface smoothness of 63 rms. Ceramic-coated dies, like $Al_2O_3$ coated tool steel, were found capable of extruding 4340 alloy steel at 2300° F and about 50 tsi, producing 2.0- by 1.5- by 0.062-in. Tee sections in lengths up to at least 40 ft with dimensional runout of less than 4 mils and surface smoothness of 125 rms. The performance of massive ceramic dies in TZM extrusion indicates that massive ceramic dies would produce steel extrusions superior to those obtained with ceramic-coated steel dies. Author

**N65-13064#** Aerospace Industries Assn. of America, Inc., Washington, D.C.
**RELIABILITY PREDICTION ADJUSTMENT FACTORS**
E. P. McDowell (Hughes Aircraft Co.) Washington, D.C., Natl. Std. Assoc., Inc., Oct. 1964 29 p
(EETC-28) Available from Natl. Std. Assoc.: $1.00

A survey was conducted among member companies of the Electronics Systems Reliability Committee to determine their practices in the application of adjustment factors when predicting electronic systems reliability. Replies are tabulated in detail. It was concluded that (1) there is little uniformity throughout the aerospace industry in the application of use environment factors, (2) the factors and failure rate data in MIL-STD-756A and MIL-HDBK-217 are frequently referred to but not universally accepted, (3) organizations prefer to use failure rates based on operating experience with their own equipments, (4) some organizations apparently prefer to use engineering judgment rather than operating data or published figures, and (5) a few organizations appear to treat reliability adjustment factors as safety factors, to be traded off with other aspects of the overall program, rather than as realistic attempts to arrive at accurate appraisals of operational reliability. R.L.K.

**N65-13067#** Dow Chemical Co., Denver, Colo. Rocky Flats Div.
**INDIUM SEALS**
R. O. Adams 2 Dec. 1964 10 p
(Contract AT(29-1)-1106)
(RFP-449) OTS: $0.50

This work demonstrates that reliable large seals can be made using indium; however, its use for repetitive operations is not recommended. The contraction that takes place when the indium solidifies requires working of the indium to provide a smooth flat sealing surface. Also, an external pressure is required to make a seal. This extra pressure is small and is easily provided, but it adds to the cycle time and to the expense of equipment. Although repeated seals can be made without remelting the indium, precise positioning of the bell jar is required to do it. The sealing edge must be placed exactly in the indentation in the indium left by the preceding seal. If the bell jar is slightly out-of-round this can be exceedingly difficult. Any damage to, or foreign matter in, this indentation makes resealing difficult or impossible. Author

**N65-13094#** Naval Air Station, Pensacola, Fla.
**[SPECTROMETRIC OIL ANALYSIS PROGRAM]**
H. Yesnes 9 Oct. 1964 13 p Review of TRECOM Tech. Rept. 63-55; See N64-14170 05-06
(OA-37-64; TRECOM-TR-63-55; AD-449731)

The Statistical Study portion of a TRECOM technical report on the evaluation of oil analysis for detection of incipient failure in aircraft engines is reviewed in detail. Since the results were inconclusive, an alternative approach is presented, viz, to test the soundness of the laboratory recommendations by the actual engine conditions. Data covering various models of reciprocating engines operated by the Naval Air Advanced Training Command during a 4-year period are discussed. It is shown that the laboratory recommendations can be related to actual engine conditions in 78% of the cases. D.S.G.

**N65-13103#** Westinghouse Electric Corp., Pittsburgh, Pa. Westinghouse Research Labs.
**MATERIAL PROCESSING AND PHENOMENA INVESTIGATIONS FOR FUNCTIONAL ELECTRONIC BLOCKS Interim Engineering Report, 6 Dec.–6 Mar. 1964**
I. M. Mackintosh 12 May 1964 31 p refs
(Contract AF 33(657)-9897)
(IER-6; AD-600355) OTS: $2.00

Electrochemical techniques in diode fabrication processes and the effects of scanning electron microscope examination on transistors were investigated. Tracer experiments with P-32 tagged diethylphosphate have clarified several important aspects of the preparation of controlled, doped, anodic oxides for producing n+-on-p diodes. Among the factors investigated were the reproducibility of the anodic oxide source, the correlation between the concentration of the doping electrolyte and the concentration in the anodic oxide, the effect of pure silicon dioxide coatings in preventing losses of phosphorus during diffusion processes, and the segregation coefficient at the

$SiO_2$–Si interface. Data obtained from electron-beam studies indicated that the beta of the transistor falls off as a function of the electronic charge introduced by the bombarding beam, and that the reverse leakage current of the junction rises. It has been shown that the devices can be restored to their initial characteristics in most cases by a combination of heat treatment and the application of electrical bias. D.S.G.

**N65-13126#** Linde Co., Indianapolis, Ind. Speedway Labs.
**GROWTH OF SINGLE CRYSTAL TUNGSTEN TO BE USED FOR ROLLING INTO SINGLE CRYSTAL SHEET**
[1964] 41 p refs
(AD-605832) OTS: $2.00

CONTENTS:
1. FABRICATION AND PROPERTIES OF TUNGSTEN SINGLE CRYSTALS F. R. Charvat and G. W. Edwards 10 p refs (See N65-13127 03-15)
2. SINGLE CRYSTAL TUNGSTEN SHEET L. Raymond and I. Neumann 29 p refs (See N65-13128 03-17)

**N65-13127#** Linde Co., Indianapolis, Ind. Speedway Labs.
**FABRICATION AND PROPERTIES OF TUNGSTEN SINGLE CRYSTALS Quarterly Progress Report, Jun. 1–Aug. 31, 1964**
F. R. Charvat and G. W. Edwards 28 Aug. 1964 *In its* Growth of Single Crystal Tungsten to be Used for Rolling into Single Crystal Sheet [1964] 10 p refs (See N65-13126 03-15)
(Contract NOw-64-0055-c)
(QPR-2) OTS: $2.00

The tungsten crystal billets produced were examined intensively to determine the crystal imperfections in the billet before commencing with the rolling of the material into sheet. The tungsten crystals were grown using the Arc–Verneuil technique and commercially available high purity tungsten powder. Of the twenty-four tungsten crystals grown, seven were selected for machining into rectangular billets on the basis of minimum crystal misorientation and deviation of crystal orientation from cylindrical axis. Chemical analysis of the finished billets for interstitial and metallic impurities showed satisfactory low levels. D.S.G.

**N65-13133#** Clevite Corp., Bedford, Ohio. Piezoelectric Div.
**PRODUCTION ENGINEERING MEASURE FOR CERAMIC FILTERS Sixth Quarterly Report, 30 Jun.–29 Sep. 1964**
A. Lungo [1964] 18 p
(Contract DA-36-039-AMC-01471(E))
(Rept.-6; AD-608465)

Problems encountered in pressing 1.75-Mc radially resonant disks having raised centers for electrical contact and mechanical support are discussed. The solutions to these problems are also discussed. Difficulties that developed in applying the new electroding technique to thin ceramic disks are discussed. The solution to these difficulties is included. A new tumble grinding technique is presented that appears to meet the requirement for a low cost ceramic-disk tuning method.
Author

**N65-13237#** Thompson Ramo Wooldridge, Inc., Cleveland, Ohio. TAPCO Div.
**TUNGSTEN FORGING DEVELOPMENT PROGRAM Eighth Interim Technical Progress Report, 19 Feb.–19 May 1963**
E. J. Breznyak May 1963 42 p refs
(Contract AF 33(600)-41629)
(ASD-TR-7-797(VIII); AD-410145)

Methods of producing tungsten forgings for the structural use in aerospace vehicles were revised and extended to forging of thin sections of nonstructural tungsten shapes that are required for the rocket industry. Emphasis is placed on the development and verification of this section-forging process. A thin-wall nozzle insert technology was used for the scaled-up thin-section forging-process configuration. Arc-melted and extruded, unalloyed, forging billet stock was machined to the specified 3.750-in. diameter by 6.500-in. length and underwent surface and ultrasonic testing and chemical analysis. No surface discontinuities or internal defects were detected, and the vendor analysis, as well as the carbon and oxygen analysis, was within the specification limits. G.G.

**N65-13238#** United Aircraft Corp., East Hartford, Conn. Research Labs.
**EXPLORATORY INVESTIGATION OF GLASS-METAL COMPOSITE FIBERS Bimonthly Progress Report No. 3, Aug. 14–Oct. 13, 1964**
J. E. Cox and R. D. Veltri 10 Nov. 1964 20 p
(Contract NOw-64-0389-f)
(C910242-3; AD-609116)

Several techniques were investigated as possible means of introducing molten beryllium into the forming zone of glass fibers being drawn from glass tubing. Protective coatings on beryllium wire and protection tubes inside the glass tube have been tried as means of limiting the reaction time between beryllium and glass. Only a few short lengths of beryllium–glass composite fibers were obtained. Preliminary experiments have also been made on means of removing glass coatings from hand-drawn beryllium–glass composites. Work on copper–glass composites was limited to improvements in apparatus. Author

**N65-13268#** Arde-Portland, Inc., Paramus, N.J.
**DEVELOPMENT AND FABRICATION OF HIGH STRENGTH SIMULATED ROCKET MOTOR CASES BY CRYOGENIC STRETCH FORMING PROCESS Final Report**
31 Oct. 1964 322 p
(Contract AF 33(657)-9638)
(AD-608665)

CONTENTS:
1. DETERMINATION OF THE WELDING AND MATERIAL CHARACTERISTICS OF CRYOGENICALLY STRETCHED MATERIAL 106 p (See N65-13269 03-15)
2. FABRICATION OF SUB-SCALE AND FULL SCALE CASES. SECTION A: FABRICATION AND TESTING OF SUB-SCALE VESSELS 71 p (See N65-13270 03-15)
3. FABRICATION OF SUB-SCALE AND FULL SCALE CASES. SECTION B: FABRICATION AND TESTING OF FULL SCALE VESSELS 134 p (See N65-13271 03-15)

**N65-13269#** Arde-Portland, Inc., Paramus, N.J.
**DETERMINATION OF THE WELDING AND MATERIAL CHARACTERISTICS OF CRYOGENICALLY STRETCHED MATERIAL**
*In its* Develop. and Fabric. of High Strength Simulated Rocket Motor Cases by Cryog. Stretch Forming Process 31 Oct. 1964 106 p (See N65-13268 03-15)

Uniaxial testing of cryogenically prestrained thick-plate specimens was performed. The specimen configurations included variables of thickness, aging, degree of cryogenic prestrain, and welding. The plate stock of all thicknesses was

rolled from the same heat of 301 stainless steel. This material was also used in the fabrication of a full-scale vessel and the cylindrical portions of a subscale vessel. The plate stock was fabricated into various specimens incorporating variables of thickness, rolling direction, and longitudinal and transverse welds. Among the results indicated were the following: (1) Cryogenic prestrains of 285 000 psi result in a room-temperature true ultimate-strength level of 250 000 to 270 000 psi. (2) Aging at 800° F for 20 hours increases it to about 300 000 psi. (3) The material thickness, the direction of rolling, and the incorporation of welds had no appreciable effects on material strength. D.S.G.

**N65-13270#** Arde-Portland, Inc., N.J.
**FABRICATION OF SUB-SCALE AND FULL SCALE CASES. SECTION A: FABRICATION AND TESTING OF SUB-SCALE VESSELS**
*In its* Develop. and Fabric. of High Strength Simulated Rocket Motor Cases by Cryog. Stretch Forming Process 31 Oct. 1964 71 p (See N65-13268 03-15)

The specific areas investigated in the subscale program were weld-beam design, preform configuration, and weld-bead strength improvement. A weld process was developed for thick-walled vessels; this process consists of a heliarc (tungsten inert gas) root pass weld, combined with a sigma-arc (consumable electrode) overpass weld. The most efficient weld-bead design incorporated the removal of the underbead to provide a surface flush with the parent metal, eliminating the notch effect at the intersection of the weld-bead and the parent metal. Although the preform test vessel failed prematurely due to a thinned-out area, the test demonstrated that the preform design would result in a cryogenically stretched vessel of the desired contour. The weld-strength improvement study indicated that the use of 301 weld wire would provide a weld bead more consistent with the 301 parent metal than the currently used 308 weld wire. D.S.G.

**N65-13271#** Arde-Portland, Inc., Paramus, N.J.
**FABRICATION OF SUB-SCALE AND FULL SCALE CASES: SECTION B: FABRICATION AND TESTNG OF FULL SCALE VESSELS**
*In its* Develop. and Fabric. of High Strength Simulated Rocket Motor Cases by Cryog. Stretch Forming Process 31 Oct. 1964 134 p (See N65-13268 03-15)

The full-scale program resulted in the fabrication of (1) the 65-in.-diam stretch die; (2) a simple 65-in. preform to establish handling processes; and (3) two full-scale vessels, one cryogenically prestrained to approximately 165 000 psi strength level and the other to approximately 200 000 psi. The testing of the two full-scale vessels was prematurely terminated due to weld failure at the head-to-cone girth weld. It was determined that the failures were caused by a combination of delamination of the material and precipitation of carbides in the weld area. This condition resulted in fracture during the transition from the "dog-bone" preform shape to the final elliptical shape. D.S.G.

**N65-13309*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**STATE-OF-THE-ART LITERATURE SURVEY ON FABRICATION TECHNIQUES OF ADVANCED DUCTING COMPONENTS**
C. N. Irvine and J. H. Barnett 2 Dec. 1964 76 p refs
(NASA-TM-X-53173) OTS Prices: HC $3.00/MF $0.75

This report briefly covers the methods currently used in elbow, bellows, and ducting fabrication as well as some alternate methods under development. Some information concerning the properties and fabricability of several aluminum, iron-base, nickel-base, and cobalt-base alloys suitable for use in cryogenic ducting systems is also presented. The survey indicates that advancements in the state-of-the-art of fabricating large-diameter elbows, bellows, and ducting will be necessary for new, larger ducting system applications. Author

# 16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

**N65-12477#** Ohio State U. Research Foundation, Columbus. Antenna Lab.
**EXPERIMENTAL DATA ON THE BREAKDOWN OF AIR AND ARGON BY A RUBY LASER PULSE**
R. G. Tomlinson and E. K. Damon 1 Jun. 1964 23 p
(Contract AF 33(657)-10824)
(Rept.-1579-12; AD-443784)

Data on laser-induced gas breakdown in air and argon were taken as functions of gas pressure and peak laser-pulse power. As the gas pressure is lowered for a fixed laser-pulse power, or as the peak laser power is lowered for a fixed gas pressure, breakdown occurs at a later and later time relative to the beginning of the laser pulse, until a threshold is reached below which breakdown does not occur. These data are primarily measurements of percent laser-pulse energy transmitted through the breakdown region. Direct photographs of the focused laser spot were made and used to convert power measurements to electric field strength values. Author

**N65-12920#** Brown Engineering Co., Inc., Huntsville, Ala. Research Labs.
**OBSERVATION OF STATISTICAL FLUCTUATIONS IN OPTICAL SECOND HARMONIC GENERATION**
J. William Foreman, Jr. Nov. 1964 22 p refs
(TN-R-121; AD-608670)

Measurements of the statistical fluctuations in optical second-harmonic generation have been made using both short- and long-time constant detector circuits. The second harmonic was generated by focusing the beam from a standard ruby laser (not Q-switched) on a KDP crystal mounted approximately in the phase-matched orientation. As expected, the measured fluctuations were smaller in the long-time constant case. A steady decrease in second-harmonic output was observed throughout the measurements. Some possible reasons for this anomalous effect are discussed. Author

**N65-12952#** Joint Publications Research Service, Washington, D.C.
**SEMICONDUCTOR QUANTUM GENERATORS**
N. G. Basov 16 Dec. 1964 20 p Transl. into ENGLISH from Vestn. Akad. Nauk (Moscow), no. 9, Sep. 1964 p 19-33
(JPRS-27-881; TT-64-51955) OTS: $1.00

The use of optical quantum electronics for the study of the interaction of light with various substances in high intensity electrical fields is discussed. The mechanics of the resonance

absorption and of induced radiation as well as spontaneous radiation in quantum electronics are presented. The creation of quantum generators and amplifiers is developed, and a general overview of the characteristic features of various semiconductors and their application is given. G.G.

**N65-12961#** Harvard U., Cambridge, Mass. Cruft Lab.
**A 21-CENTIMETER TRAVELING-WAVE MASER**
E. B. Treacy 22 Jan. 1963 40 p refs
(Contract Nonr-1866(28))
(TR-401; AD-405055)

A traveling-wave maser, tunable over the frequency range of 1340 to 1430 Mc, was developed and constructed for use in radio astronomical research. It uses ruby as the maser material and a comb as the slow-wave structure. The net gain exceeds 30 dB over most of its tuning range, and the average instantaneous bandwidth is about 11 Mc. It has been designed for operation at 4.2° K. Author

# 17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

**N65-12417*#** Boeing Co., Seattle, Wash. Aero-Space Div.
**IDENTIFYING OPTIMUM PARAMETERS OF HOT EXTRUSIONS Progress Report No. 2, Jul. 14–Oct. 19, 1964**
[1964] 34 p refs
(Contract NAS7-276)
(NASA-CR-59708) OTS Prices: HC $2.00/MF $0.50

The purpose of this program is to develop a technique for hot extruding MgO and to determine the effect of hot extrusion on MgO with preliminary evaluations on other oxide bodies. Approximately 50 ceramic billets have now been prepared, including MgO billets with less than 1% porosity fabricated without additives. Three extrusions in tungsten cans were made. Several uncanned extrusions were completed; however, a weighing of factors has lead to the selection of canned extrusion as the primary technique for the remainder of this program. Further evaluation of previous CaO extrusions showed that substantial recrystallization occurs after extrusion; however, no further recrystallization has been observed on annealing to 1370° C. Significant interaction of extrusion and alloying was shown both by redistribution of the CaO rich phase in MgO–5 wt% CaO and by greater orientation of phases in CaO–14 wt% MgO, MgO–1 wt% $Al_2O_3$, and MgO–2 wt% NiO than in a similar pure MgO body. Author

**N65-12444** Notre Dame U., Ind.
**SINTERING PHENOMENA IN CERAMIC SYSTEMS Final Report, Nov. 1957–Nov. 1962**
G. C. Kuczynski Jul. 1964 15 p refs
(Contract Nonr-1623(06))
(AD-603267) OTS: $1.00

The following topics are presented: "The Effects of Grain Boundaries on Neck Growth and on the Rate of Closure of Pores"—the grain boundaries as vacancy sinks during the first stage of sintering and in the elimination of the pores during the second stage of sintering; "Mechanism of Sintering of Oxides"—the sintering mechanism in $Fe_2O_3$, and some binary systems such as MgO-$Fe_2O_3$, MgO-$Al_2O_3$ and MgO-NaCl; and "Sintering of Sulphides"—the sintering of ZnS containing 0.1% Cu. G.G.

**N65-12482#** Universal-Cyclops Steel Corp., Bridgeville, Pa. Refractomet Div.
**DEVELOPMENT OF PROCEDURES FOR SHAPE ROLLING COLUMBIUM ALLOYS Sixth Interim Technical Progress Report, 1 Jul.–1 Oct. 1964**
F. R. Cortes Oct. 1964 26 p
(Contract AF 33(657)-10831)
(ASD-8-108 (VI); AD-450079)

The metallurgical condition of the 1 15/16-in. diameter starting bar of Cb-752 alloy, for shape rolling to a "hat" shaped section, was tentatively selected as a moderately worked (40% to 45%) structure. A rough-rolling temperature of about 2150° F appeared optimum. A tentative eight-pass roughing sequence was developed to produce a rough shape capable of being rolled to the dimensional objectives of the program. The finish rolling operation, applying an average area reduction of 27.6%, was taken cold or warm in 2 to 5 passes, depending on the low-temperature fabricability of the final rough shape. Factors influencing the selection of the above parameters are discussed. Mechanical properties of the as-rolled and recrystallized shapes, hot–cold rolled to finish with no intermediate anneals, were determined at room temperature and 2200° F. The effect of a duplex annealing treatment was also determined. R.L.K.

**N65-12483#** Stockholm U. (Sweden). Inst. of Inorganic Chemistry
**PHASE ANALYSIS AND CRYSTAL STRUCTURE STUDIES ON BINARY ALLOYS OF ALUMINUM WITH TRANSITION METALS Final Technical Report No. 1, 1 Oct. 1963–30 Sep. 1964**
Arne Magneli, Lars-Erik Eoshammar, Tore Dagerhamn, and Sven Westman Oct. 1964 88 p refs
(Contract DA-91-591-EUC-3134)
(AD-451442)

The work reported in this document has been performed in continuation of X-ray studies previously conducted on phase conditions and crystal structures of transition metal aluminides at different temperatures. Studies on the yttrium–aluminum system have shown that the phase conditions are complicated at high contents of aluminum. Data are given on the high-temperature structural properties of titanium aluminides. Phase analysis studies on the ruthenium–aluminum system have demonstrated the existence of three phases, namely RuAl, $RuAl_2$ and $Ru_4Al_{13}$. Osmium and aluminum have been found to form four intermediate phases, namely OsAl, $Os_2Al_3$, $OsAl_2$ and $Os_4Al_{13}$. The crystal structures have been determined. The crystal structure of the cubic $\gamma$-$Cu_9Al_4$ phase ($D8_3$-type) has been refined, using data collected with a single-crystal X-ray diffractometer. The refined structure is described in terms of atomic clustering, coordination, and bond lengths. Author

**N65-12492#** United States Steel Corp., Monroeville, Pa. Applied Research Lab.
**A METALLOGRAPHIC INVESTIGATION OF THE FACTORS AFFECTING THE NOTCH TOUGHNESS OF MARAGING STEELS**

A. J. Birkle, D. S. Dabkowski, J. P. Paulina, and L. F. Porter
1 Jul. 1964 26 p refs
(Contract NObs-88540)
(AD-604868)

A new metallographic technique for investigating the factors affecting the toughness of steels is that of extraction fractography, a technique made possible by the extreme depth of focus of the electron microscope. This report describes the results of an investigation of nine maraging steels with widely varying notch toughness (25- to 70-ft-lb Charpy V-notch energy at 190-ksi yield strength). Extraction fractography was used in conjunction with such techniques as light microscopy, thin-film electron microscopy, microprobe analysis, and electron- and X-ray-diffraction analysis to identify the causes for the difference in toughness among the nine steels. The results of the investigation indicate that, by examining extraction fractographs with metallographic, X-ray- and electron-diffraction, and microprobe techniques, it is possible to isolate the major factors responsible for low notch toughness in maraging steels.

Author

**N65-12498** United States Steel Corp., Monroeville, Pa. Applied Research Lab.
**EFFECT OF CARBON ON THE HARDENABILITY AND MECHANICAL PROPERTIES OF 5Ni-Cr-Mo-V STEEL**
S. J. Manganello and L. F. Porter 1 Jul. 1964 20 p refs
(Contract NObs-88540)
(AD-604872)

Seven 5Ni-Cr-Mo-V steels containing 0.05% to 0.27% carbon were evaluated to establish the carbon-ordering range for the 5Ni-Cr-Mo-V steel as an HY-130/150 steel and to determine the potential of the 5Ni-Cr-Mo-V steel as an HY-180/210 steel. The results showed that an average yield strength of about 140 ksi should be obtained in 1/2-inch-thick water-quenched production plates at a carbon content of about 0.045%, but that a minimum carbon content of about 0.085% should be specified to obtain similar properties at the mid-thickness of 4-inch-thick water-quenched plates. In the tempering range 900° to 1200° F, none of the steels investigated exhibited a yield strength of 180 ksi. The high-carbon steels from the present study and other experimental steels are being evaluated at lower tempering temperatures to determine their potential as HY-180/210 steels.

Author

**N65-12501*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**PRELIMINARY INVESTIGATION OF EFFECT OF ENVIRONMENTAL FACTORS ON SALT STRESS CORROSION CRACKING OF Ti-8Al-1Mo-1V AT ELEVATED TEMPERATURES**
David N. Braski Washington, NASA, Dec. 1964 23 p refs
(NASA-TM-X-1048) OTS Prices: HC $1.00/MF $0.50

A preliminary experimental investigation was made on the effect of oxygen, moisture, pressure, surface condition, and salt composition on the salt stress-corrosion cracking of Ti-8Al-1Mo-1V titanium-alloy sheet (duplex annealed) at 550° and 600° F. The results showed that both a reduction in the oxygen content and the pressure reduced stress-corrosion cracking. Thin surface oxide films and moisture in the ranges investigated had little or no effect on the amount of stress-corrosion damage. The NaCl caused more damage than ASTM salt (six parts NaCl to one part $MgCl_2$, by weight). Moist chlorine produced severe stress-corrosion cracking. The $TiCl_2$ appeared to be one of the main corrosion products.

Author

**N65-12520#** United States Steel Corp., Monroeville, Pa. Applied Research Lab.
**FEASIBILITY OF DEVELOPING AN HY-180/210 WELDMENT Quarterly Progress Report, 1 Apr.–30 Jun. 1964**
L. F. Porter, A. M. Rathbone, S. T. Rolfe, and K. E. Dorschu
1 Jul. 1964 16 p refs
(Contract Nobs-88540)
(QPR-4; AD-604869)

Through the development of improved processing practices on small ingots, the notch toughness of air-melted 12Ni-5Cr-3Mo maraging steel appears to be equivalent to that of vacuum-consumable-electrode remelted 12Ni-5Cr-3Mo steel. Thus, light-gage plates of the 12Ni-5Cr-3Mo steel should now meet the desired minimum toughness objective (50 ft-lb at 180 ksi). However, the notch toughness of the 12Ni-5Cr-3Mo steel in plates over 2 inches thick is presently in the range 30 to 40 ft-lb. Therefore, improvements in the chemical composition and melting practice of the 12Ni-5Cr-3Mo steel are being investigated. In addition, the potential of carbon-martensitic age-hardened steels, conventional quenched and tempered steels, and rapidly heat-treated quenched and tempered steel is still being evaluated.

Author

**N65-12549#** McDonnell Aircraft Corp., St. Louis, Mo.
**A PRELIMINARY SURVEY OF METALLOGRAPHIC TECHNIQUES FOR THE EXAMINATION OF REFRACTORY METAL COATINGS**
J. P. O'Connor 30 Jun. 1964 78 p refs
(A648)

Much development work involving oxidation-resistant coatings for refractory metals depends upon the successful metallographic preparation and microscopic examination of representative samples of parent test specimens. Further consideration should be given to the following: (1) simplified methods of hard-coating sectioned specimens to preserve edge detail when mounted; (2) development of a simple cast-molding process to produce mounts comparable to those made by compression molding with diallyl phthalate resin; (3) incorporation of measures to maintain the required cleanliness of metallographic specimens, to include a suitable ultrasonic cleaning unit; (4) grinding and polishing in a direction that is principally normal to a specified edge of the coated specimen, to produce at least one flat edge; and (5) limited investigation of chemical and electrolytic polishing and etching techniques.

Author

**N65-12555#** Syracuse U. Research Inst., N.Y.
**EFFECT OF SECTION SIZE ON NOTCH STRENGTH Final Report**
G. T. Schaeffer and V. Weiss Oct. 1964 135 p refs
(Contract DA-31-124-ARO(D)-106)
(MET.E-1078-1064-FR; AROD-3136-4; AD-451518)

The effect of section size on the room temperature notch strength of H-11 steel, 2014-T6 and 7075-T6 aluminum alloys, and Plexiglas was investigated in three different series of notched, cylindrical tensile specimens and notched, rectangular bend specimens. The three test series permit the separation of the influences of the geometrical parameters, which determine the stress field near the base of the notch on the notch strength as the size of the specimen increases. The notch strength decreases with increasing size for all series investigated. The decrease in strength is most pronounced for the sharp machine-notched and fatigue-cracked specimens but it is also observed, to a much smaller degree, in the other series of notched specimens for all materials. An analysis of the results of this study indicates that the loss in strength with

increasing section size is due to at least two factors: an increase in stress concentration factor and an increase in critically stressed volume with increasing size. Author

**N65-12561#** Aerospace Corp., El Segundo, Calif. Materials Sciences Lab.
**THERMAL EXPANSION OF TITANIUM, ZIRCONIUM, AND HAFNIUM CARBIDES TO 2700°C**
J. H. Richardson 30 Oct. 1964 24 p refs
(Contract AF 04(695)-469)
(SSD-TDR-64-243; TDR-469(5250-10)-3; AD-452174)

The X-ray thermal expansion measurements on arc-cast carbides of titanium, zirconium, and hafnium are described. The coefficients of thermal expansion for these materials from room temperature to 2700° C are 9.5 $\pm 0.3 \times 10^{-6}$ per °C, 7.6 $\pm 0.2 \times 10^{-6}$ per °C, and 7.3 $\pm 0.2 \times 10^{-6}$ per °C, respectively. Author

**N65-12568#** Frankford Arsenal, Philadelphia, Pa. Research and Development Directorate
**FRACTURE CHARACTERISTICS OF SEVERAL HIGH STRENGTH ALUMINIUM ALLOYS USING VARIABLE NOTCH ROOT RADII**
Joseph H. Mulherin Sep. 1964 43 p refs
(R-1734; AD-452318)

A relationship between the stress concentration factor and the fracture-toughness parameter was examined for the case of an elliptical hole in an infinite solid. Edge-notched specimens from three high-strength aluminum alloys were tensile loaded to failure. The resulting data from these tests were analyzed, using this relationship. It was indicated that the predicted proportionality between the fracture toughness parameter and the square root of the notch root radius does exist. Further examination of the relationship showed that the fracture occurs at a fixed state of strain within a plastic zone having a size proportional to the original root radius. A departure, however, from the predicted behavior was evident with the introduction of plane strain components at the notch root. This is also discussed. Author

**N65-12587#** North Carolina State Coll., Raleigh.
**THE PREPARATION AND MECHANICAL PROPERTIES OF SPINEL. SLIP PROCESSES IN FINE GRAINED POLYCRYSTALLINE SPINEL, $MgAl_2O_4$ Final Report, Sep. 1960–Jun. 1964**
W. Wurth Kriegel, Hayne Palmour, III, and Dong M. Choi Jul. 1964 31 p refs
(Contract DA-01-009-ORD-903)
(AROD-2918-6; AD-446682)

Magnesium aluminate spinel is under consideration as a possible high-performance structural ceramic because of its chemical and thermal stability, isotropic structure, and multiple {111} <110> slip systems at high temperatures. It has been produced in fine-grained, essentially pore-free polycrystalline compacts by two different hot-pressing procedures, using feed materials prepared by two alternative methods (i.e., direct solid-state reaction of the parent oxides, coprecipitation, and calcination). Variations in microstructural features, in transverse and compressive strength, and in Young's modulus of elasticity as functions of the basic process parameters, as well as those introduced by deliberate second phases (graphite and/or pores), by oxidation state, and by feed material impurity and inhomogeniety are discussed. The marked dependence of high-temperature compressive strength on certain details of starting materials and processing is also described. Author

**N65-12601#** Joint Publications Research Service, Washington, D.C.
**DIE STEEL AND TITANIUM ALLOYS FOR HOT STAMPING**
7 Dec. 1964 18 p refs Transl. into ENGLISH from Kuznechno-Shtampovochnoye Proizv. (USSR), no. 8, Aug. 1964 p 12–15, 37–38
(JPRS-27715; TT-64-51880) OTS: $1.00

CONTENTS:

1. PROPERTIES AND APPLICATION OF MODERN DIE STEELS FOR HOT STAMPING Yu. A. Geller and Ye. S. Golubeva p 1–10 refs
2. POWER INDICES IN THE INDUCTION HEATING OF TITANIUM ALLOYS FOR HOT STAMPING I. I. Bezruchko and M. S. Ayzikovich p 11–15

**N65-12611*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**MARKED INFLUENCE OF CRYSTAL STRUCTURE ON THE FRICTION AND WEAR CHARACTERISTICS OF COBALT AND COBALT-BASE ALLOYS IN VACUUM TO $10^{-9}$ MILLIMETER OF MERCURY. I: POLYCRYSTALLINE AND SINGLE CRYSTAL COBALT**
Donald H. Buckley and Robert L. Johnson Washington, NASA, Dec. 1964 19 p refs
(NASA-TN-D-2523) OTS Prices: HC $1.00/MF $0.50

Friction and wear characteristics were determined for polycrystalline cobalt sliding on various materials (polycrystalline cobalt, 440-C, 52100, and aluminum oxide) in vacuum ($10^{-9}$ mm Hg). The influence of crystal transformation on the friction and wear characteristics of cobalt was determined by varying sliding velocity and ambient temperature. The effect of orientation of single-crystal cobalt sliding on polycrystalline cobalt was also determined. Friction and wear experiments were conducted at sliding velocities to 2000 ft/min and ambient temperatures to 850° F. Both polycrystalline and oriented single crystals of cobalt were the rider specimens (3/16-in.-rad. hemisphere) sliding on flat 2 1/2-in.-diam disks of various materials. Factors studied were the influences of crystal transformation and single crystal orientation on the friction and wear characteristics of cobalt. Author

**N65-12633#** Battersea Coll. of Tech. (Gt. Brit.)
**USE OF REACTIVE ATMOSPHERES FOR THE TREATMENT OF B.C.C. METALS Quarterly Engineering Progress Report No. 7**
I. J. Toth [1964] 31 p refs
(Contract N62558-3591)
(AD-444957)

High-frequency heating apparatus was used to obtain a complete series of results on the bromine activation of the sintering of tungsten. The results are presented in tabular and graphical form. The temperature range 1200° to 1700° C is covered; sintering times are from 15 to 240 minutes. Bromine activation occurs in this temperature range, the maximum effect being at 1400° C. Bend tests showed that more consistent results can be obtained after a light surface polishing. An increase in bend-strength–density ratio was observed for bromine-treated test pieces. Nickel and palladium activation was studied further, especially from the point of view of improving mechanical properties. Sintered test pieces and tungsten–nickel diffusion couples were submitted to electron-probe microanalysis. D.E.W.

**N65-12640#** Royal Aircraft Establishment, Farnborough (Gt. Brit.)

**THE NATURE OF THE ω PHASE IN QUENCHED ALLOYS OF TITANIUM [O PRIRODE ω-FAZY V ZAKALENNYKH SPLAVAKH TITANA]**

Yu. A. Bagaryatskii, G. I. Nosova, and T. V. Tagunova London, Min. of Aviation, Aug. 1964 10 p refs Presented at the 5th Intern. Congr. of Crystallographers, Cambridge, Gt. Brit., Aug. 1960

(RAE-TRANS-1072)

The ω phase that is found in certain quenched titanium alloys was studied and was shown to satisfy three of the four basic properties of a martensitic phase, as follows: (1) The transformation is diffusionless. (2) The rearrangement of the lattice occurs by small atomic movements, and neighbors in the β phase remain neighbors in the ω phase. (3) The transformation can be directly reversed. Unlike normal martensitic reactions, however, surface rumpling does not occur. This is because adjacent planes of atoms move in opposite directions, instead of in similar ones as for normal martensites, so that large displacements do not arise. It is claimed, therefore, that the ω phase is a martensitic phase of a special type. Author

**N65-12659#** Iowa State U. of Science and Tech., Ames. Ames Lab.

**OXIDATION STUDIES OF SOME REFRACTORY METALS**

James Henry Witte and Harley A. Wilhelm Feb. 1964 36 p refs

(Contract W-7405-ENG-82)

(IS-854)

Samples of niobium, tantalum, molybdenum, and tungsten metals have been given phosphided cases by heating in a phosphorous atmosphere. The samples were subsequently exposed to air at an elevated temperature. In tests at 800° C, the phosphided samples resisted air oxidation markedly compared to the pure untreated samples. The phosphided cases were only a few microns thick, yet oxidation resistance of all these samples extended for several hours. Phosphided samples with 90° edges did not resist oxidation at the edges as well as rounded edge samples. Author

**N65-12730*#** Pressure Technology Corp. of America, Woodbridge, N.J.

**AN INVESTIGATION OF FLUID EXTRUSION OF METALS**

**Third Quarterly Report, Jan. 1–Apr. 1, 1964**

1 Apr. 1964 27 p refs

(Contract NASw-742)

(NASA-CR-59639) OTS Prices: HC $2.00/MF $0.50

Tensile tests and fluid-to-fluid extrusions were made of a chromium dispersion hardened with magnesium oxide. Orthotropism was found in the powder-metallurgy product. Tensile tests were conducted on tungsten–tantalum alloys. This arc-cast material exhibited inhomogeneity due to the large grain size. Hafnium carbide continues to be brittle in tensile tests under pressure. Author

**N65-12739#** California U., Livermore. Lawrence Radiation Lab.

**ISOTHERMAL TRANSFORMATION STUDY OF SOME URANIUM-BASE ALLOYS**

C. A. W. Peterson, W. J. Steel, and S. L. Di Giallonardo Aug. 1964 30 p ref

(Contract W-7405-ENG-48)

(UCRL-7824) OTS: $2.00

Isothermal time–temperature-transformation characteristics are presented for the gamma phase of alloys of uranium with molybdenum, niobium, and zirconium. The changes in hardness and microstructure are described and correlated with the time, as determined by resistivity measurements, to initiate transformation at a given temperature. Author

**N65-12762#** Joint Publications Research Service, Washington, D.C.

**CONFORMITIES OF THE TENDENCY OF STEEL TO BRITTLE FRACTURE AT HIGH AND LOW TEMPERATURES**

A. V. Stanyukovich 18 Dec. 1964 12 p refs Transl. into ENGLISH from Metalloved. i Term. Obrabotka Metal. (Moscow), no. 7, 1964 p 2–7

(JPRS-27905; TT-64-51968) OTS: $1.00

A study of the deformation capacity of steels and alloys at high temperatures is discussed. Conclusions reached from the results of various investigations include the following: (1) A change of relative elongation of perlitic steels with temperature, at constant rate of deformation, is characterized by a curve having three minima. The appearance of the first minimum is brought about by the phenomenon of cold-shortness, the second by deformation, and the third by the action of high-temperature intercrystalline fracture. (2) With a decrease in the rate of deformation, the tendency to brittle fracture appears at lower temperatures. (3) The factors intensifying the diffusion processes displace the curve of ductility-change-with-temperature toward lower temperatures, and vice versa. P.V.E.

**N65-12769#** Hanford Atomic Products Operation, Richland, Wash. Hanford Labs.

**THE EFFECTS OF HOT-WATER THERMAL TREATMENTS ON THE COLD WORK RECOVERY OF ZIRCALOY-2**

A. L. Bement and J. E. Irvin Oct. 1964 40 p refs

(Contract AT(45-1)-1350)

(HW-80309) OTS: $2.00

The effects of thermal treatments on the cold-work recovery of Zircaloy-2 were determined from tensile properties. Specimens were taken from the rolling and transverse directions of cold-rolled plates containing various percentages of cold work. The annealing temperatures approximate those commonly employed for autoclave treatments given either fuel cladding or process tubing before nuclear reactor service. Specimens containing various percentages of cold work were also exposed in a hot-water loop for times ranging to about 3500 hours to determine property changes resulting from thermal effects alone during long-term neutron irradiation in a hot-water environment. The specimens were given an autoclave treatment before loop exposure. Conclusions reached include the facts that substantial cold-work recovery occurs in longitudinal specimens at both 360° and 425° C for all cold work levels, that the response to recovery varies with testing direction, and that recrystallization was not observed for any of the cold-work levels after 72 hours at 425° C. D.E.W.

**N65-12793#** Atomic Energy Commission, Washington, D.C. Div. of Technical Information

**CORROSION OF METALLIC MATERIALS BY URANIUM HEXAFLUORIDE AT HIGH TEMPERATURE [CORROSION DE MATERIAUX METALLIQUES PAR L'HEXAFLUORURE D'URANIUM A HAUTE TEMPERATURE]**

G. Langlois Nov. 1964 134 p refs Transl. into ENGLISH of Rept.-CEA-2385, 1963 117 p

(CEA-2385; AEC-TR-6504) OTS: $4.00

The effects of gaseous uranium hexafluoride on various metallic materials at high temperatures were investigated under conditions similar to those obtained in isotopic separation plants. The test method employed consisted in maintaining metal platelets at temperatures between 50° and 150° C in the presence of the corrosive gas in stainless steel or glass vessels for a few hundred hours, and then weighing these samples within a few micrograms. An extensive range of metals was studied in this way. Some, such as gold, platinum, nickel, Monel, and Inconel, exhibited weight variations too slight to permit them to be classified or to predict their behavior at high temperatures. It was concluded that the solution of the corrosion problem consists in raising the maximum use temperature of the metals involved by improving their purity. D.E.W.

**N65-12823#** United States Steel Corp., Monroeville, Pa. Applied Research Lab.
**EVALUATION OF 2-INCH-THICK ELECTRON-BEAM WELDMENTS**
L. P. Connor and A. M. Rathbone 1 Jul. 1964 25 p refs
(Contract NObs-88540)
(S-22402; AD-604875)

Because electron-beam welding appeared to offer promise for joining HY-180/210 steel plates, an evaluation of 2-inch-thick electron-beam weldments was undertaken to determine whether electron-beam welding could provide any metallurgical advantages over the more conventional welding processes. Sample electron-beam weldments were fabricated from 2-inch-thick 12Ni-5Cr-3Mo steel plates (at a 180-ksi yield strength) and also from 2-inch-thick 5 1/4Ni-Cr-Mo-V steel plates (at a 140-ksi yield strength) by using the low-voltage (Sciaky) process and also by using the high-voltage (Hamilton-Standard) process. Radiographic and metallographic inspections disclosed that all the weldments contained defects, such as lack of penetration, lack of fusion, porosity, and/or microcracks. The results of mechanical-property tests of the 5 1/4Ni-Cr-Mo-V weldments indicated that, in flaw-free regions, the electron-beam weldments exhibited good strength and ductility, moderately good weld-metal toughness, and excellent heat-affected-zone toughness. Author

**N65-12832#** Battelle Memorial Inst., Columbus, Ohio.
**NITROGEN-INDUCED INTERNAL FRICTION IN CHROMIUM-35 a/o RHENIUM**
Mark J. Klein 24 Nov. 1964 22 p refs
(Contract W-7405-ENG-92)
(BMI-1703) OTS: $0.50

An internal-friction profile induced by nitrogen in chromium–35 a/o rhenium was studied as a function of nitrogen concentration and heat treatment. From these studies, the solubility of nitrogen in this alloy was deduced. The equilibrium solubility of nitrogen in this alloy did not differ significantly from that in chromium determined by internal-friction techniques. However, the precipitation kinetics of nitrogen from solution appear to be slower in the alloy than in chromium. Author

**N65-12853#** United States Steel Corp., Monroeville, Pa. Applied Research Lab.
**DEVELOPMENT OF AN HY-130/150 WELDMENT Quarterly Progress Report, 1 Apr.–30 Jun. 1964**
L. F. Porter, A. M. Rathbone, S. T. Rolfe, and K. E. Dorschu 1 Jul. 1964 22 p refs
(Contract NObs-88540)
(QPR-4; AD-604870)

Laboratory development studies on a submarine hull weldment indicate that the 5Ni-Cr-Mo-V steel appears to be the optimum composition for an HY-130/150 steel. Ingots have also been cast from an OSM heat of the 5Ni-Cr-Mo-V steel for consumable-electrode remelting and for processing to a ring forging, and plans for producing castings and structural shapes have been formulated. Weldability studies, which defined composition limits of the steel, show the heat-affected-zone crack susceptibility was low and toughness high. Covered-electrode and MIG weld metals of improved strength and toughness have been developed. A comprehensive program to evaluate the plastic-fatigue and fracture-toughness properties of 5Ni-Cr-Mo-V weldments has been planned, and 2-inch-thick plates of the 5Ni-Cr-Mo-V steel are being formed under shipyard conditions to confirm predictions on cold formability and to establish the effects of cold forming on mechanical properties. Author

**N65-12854#** Battelle Memorial Inst., Columbus, Ohio. Defense Metals Information Center
**METALS JOINING Review of Recent Developments**
R. M. Evans 13 Nov. 1964 4 p refs

Reports on research programs recently completed or in progress in the field of metals-joining technology are briefly summarized. The following subjects are included: (1) aluminum—fracture toughness of aluminum alloy weldments, repairing foundry defects in aluminum alloy castings, welding cast aluminum to wrought aluminum, and joining aluminum to steel; (2) nickel—resistance welding and fusion welding processes on Rene 41, and production of jet engine and aerospace parts using nickel alloys; (3) refractory metals and alloys—welding techniques for niobium alloys; and (4) steels—welding technology for high-strength martensitic and bainitic steels, and use of 5Ni-Cr-Mo-V steel for submarine hulls. D.S.G.

**N65-12880** Syracuse U., N.Y. Metallurgical Research Labs.
**CRACK INITIATION IN METALLIC MATERIALS Quarterly Progress Report No. 2**
V. Weiss, P. Packman, G. Nash, and K. Schroder Jul. 1964 16 p refs
(Contract NOw-64-0275-d)
(MET.E-1160-0764-QP2; AD-603785)

The mechanisms of crack initiation in LiF single crystals were studied, and a value for Neuber's finite particle size was determined. A dislocation reaction was proposed to account for the etch-pit patterns observed at the crack tips in the LiF crystals, and the strain energy obtained from this model was compared to the strain energy obtained from continuum elasticity considerations. Calibration of the fatigue fixture used in the experimental program was completed, and crack growth studies in fatigue specimens of AISI 301 stainless steel are under way. Studies of the stress variation due to relaxation and change in the load-carrying cross-sectional area in the specimen caused by the presence of the crack are also in progress. Author

**N65-12885#** Battelle Memorial Inst., Columbus, Ohio. Research and Technology Div.
**INVESTIGATION OF HIGH-TEMPERATURE REFRACTORY METALS AND ALLOYS FOR THERMIONIC CONVERTERS Seventh Quarterly Progress Report**
J. A. De Mastry and N. M. Griesenauer 10 Oct. 1964 19 p ref
(Contract AF 33(657)-10404)
(AD-449688)

Eleven refractory metals and alloys were selected for corrosion studies in lithium (2500° to 3000° F) and cesium (2500° to 3400° F) and for compatibility studies with UN, UC, and $UO_2$ at 2500° to 3400° F. Tungsten, W-0.9Cb, W-15Mo, and W-25Re are attacked by lithium after 1000 hours of exposure at 3000° F. The TZM alloy is not attacked. The tungsten-base materials including tungsten, W-0.9Cb, W-15Mo, and W-25Re undergo severe surface dissolution after exposure to 3400° F cesium vapor for 1000 hours. The TZM does not appear to be attacked by the cesium. The rhenium, Mo-50Re, and W-10Re alloys are not attacked by lithium or cesium after 100 hours of exposure at 2500° and 2800° F. Studies to bond yttria to tungsten and/or TZM have not been successful as yet. Author

**N65-12891#** Technische U., Berlin (W. Germany).
**INVESTIGATION OF GRAIN GROWTH DURING RECRYSTALLIZATION OF IRON 3 PER CENT SILICON STEEL, NOTE III Final Technical Report, Jul. 1, 1963–Jun. 30, 1964**
Ina Tönjes, Karl Löhberg, and Horst Weiss Jul. 1964 44 p
(Contract DA-91-591-EUC-2867)
(AD-449544)

Iron–3% silicon steel sheets were investigated for primary recrystallization, for processes occurring before primary recrystallization, and for strain aging. Tests on strained and tempered sheets indicate that higher degrees of strain result in higher coercivity values and that the absolute amount of coercivity is influenced by the carbon and sulfur content of the sheet. Primary recrystallization was studied on cold rolled sheets annealed in the temperature range between 50° and 800° C. Measurements of hardness, static, and dynamic coercivity, maximum field intensity, and electric resistivity indicate that precipitation processes occur in the temperature range up to 500° C and that preprecipitation or ordering processes occur in the homogeneous silicon ferrite. Primary recrystallization was found to start when a hardness of about 150 to 160 kp/mm$^2$ is reached and to be independent of annealing temperature. However, the orientation of the nuclei of recrystallization is temperature dependent, and the formation (but not the growth) of such nuclei may depend on the orientation of the deformed grains. M.P.G.

**N65-12948#** United States Steel Corp., Monroeville, Pa. Applied Research Lab.
**THE EFFECTS OF LOW-TEMPERATURE TEMPERING ON THE PROPERTIES OF 0.25 PERCENT CARBON Ni-Cr-Mo STEELS**
S. J. Manganello and L. F. Porter 1 Jul. 1964 8 p refs
(Contract NObs-88540)
(S-21103-1; AD-604876)

Previous studies indicated that an average yield strength of 180 ksi could not be attained in conventional quenched and tempered steels containing a maximum of 0.25% carbon at tempering temperatures above about 900° F. Therefore, because weldability considerations dictate the lowest possible carbon content, five selected steels (3Ni-Cr-Mo-Cb, 3Ni-Cr-Mo, 5Ni-Cr-Mo, and two 5Ni-Cr-Mo-V steels) containing 0.22% to 0.27% carbon were evaluated after tempering at appropriate temperatures to determine their suitability as HY-180/210 steels. The results indicated generally that the five steels had adequate hardenability for 4-in.-thick plates, and that yield strengths of about 185 ksi were attained at a carbon content of 0.25% carbon when the steels were tempered at temperatures in the range 400° to 1000° F. In addition, none of the steels was significantly embrittled by tempering. Author

**N65-12949#** United States Steel Corp., Monroeville, Pa. Applied Research Lab.
**EVALUATION OF MISCELLANEOUS EXPERIMENTAL HY-130/150 STEELS**
D. S. Dabowski, S. J. Manganello, and L. F. Porter 1 Jul. 1964 10 p ref
(Contract NObs-88540)
(S-11219; AD-604878)

The experimental HY-130/150 steels investigated consist of three Mn-Ni-Cr-Mo steels, three 5 1/4% to 7 1/2% nickel steels, four 5Ni-Cr-Mo steels, and two HY-80 steels. The results of the evaluation of the 12 steels indicated that none of the steels was particularly attractive as an HY-130/150 steel and that each steel exhibited one or more shortcomings, such as inadequate hardenability, low strength, poor notch toughness, or lack of sufficient resistance to softening on tempering. However, the studies did show that a reduction in the carbon, manganese, and/or sulfur content significantly improved the notch toughness of the 5Ni-Cr-Mo steels. However, compensating alloy additions must be made to offset the loss in hardenability when carbon and manganese are reduced.
Author

**N65-12951#** Joint Publications Research Service, Washington, D.C.
**STUDIES IN HEAT ENGINEERING**
14 Dec. 1964 18 p refs Transl. into ENGLISH from Teploenerg. (Moscow), no. 8, Aug. 1964
(JPRS-27-820; TT-64-51931) OTS: $1.00

Two studies are presented: (1) the comparison of welded joints for steam pipelines from perlitic and austenitic steel; and (2) the effects of heating time on the structure and properties of Cr-Mn-Ni steels. The first study investigated the unequal efficiency of welded joints of steam pipelines that are used for thermal electric power stations. A high inclination for hot crack formations was observed in the weld joint zone of the austenitic steel but found absent in the welding for steam pipelines from perlite steel. This was explained by the high heat up to 14 000° C in the perlite steel welding which induced high plastic properties. In the second study, the effects of temperatures of 500, 550 and 650° C up to 2000 hrs were observed on steels containing nitrogen and niobium for stabilization and also on steels without nitrogen but containing titanium. A maximum temperature of 460 to 470° C was determined at which these steels still do not have a susceptibility to intergranular corrosion. G.G.

**N65-12965#** National Bureau of Standards, Washington, D.C.
**PROCEDURES FOR PRECISE DETERMINATION OF THERMAL RADIATION PROPERTIES, NOVEMBER 1962–OCTOBER 1963**
Joseph C. Richmond, Davis P. Dewitt, and Warren D. Hayes, Jr. 20 Nov. 1964 62 p
(Contract DO-33(616)-61-02)
(NBS-TN-252; AD-451284) GPO: $0.40

The preliminary design of an integrating-sphere reflectometer, utilizing a helium–neon continuous-wave gas laser as the source, for measuring the reflectance of specimens at high temperature was completed. Development work on an ellipsoidal mirror reflectometer for measuring spectral reflectance of specimens in the wavelength range of 2μ to 15μ at room temperature was continued. The study of equations relating spectral emissivity of metals to other properties was continued. Platinum–13% rhodium and oxidized Inconel working standards of normal spectral emittance were calibrated over

the wavelength range of 1μ to 15μ at temperatures of 800°, 1100°, and 1300° K. Several modifications of the normal spectral emittance equipment were made to permit operation in the 15μ to 35μ range. Author

**N65-12993#** MSA Research Corp., Callery, Pa. Research Div.
**FACTORS AFFECTING THE COMPATIBILITY OF LIQUID CESIUM WITH CONTAINMENT METALS Technical Documentary Report, 1 Jul. 1963–15 Aug. 1964**
F. Tepper and J. Greer Wright-Patterson AFB, Ohio, AF Mater. Lab., Nov. 1964 43 p refs
(Contract AF 33(657)-9168)
(AFML-TR-64-327; AD-608385)

Mechanisms associated with the corrosive attack of refractory metal alloys and superalloys by liquid cesium have been investigated. The superalloys, Haynes-25 and TD-Nickel, were exposed at 1800° F, and the refractory metal systems, Mo-1/2Ti, Cb-1Zr, Ta-10W, and Cb-25Ta-12W-1/2Zr were exposed at 2100° and 2500° F. Pure nickel and pure zirconium were employed as dissimilar metal additions in some tests. Boiling reflux tests of each alloy candidate were performed. Metal solubility studies showed the solubility of the refractory metals columbium and molybdenum to be approximately 10 to 20 ppm at 2500° F. Dissimilar metal tests showed mass transfer of metallic elements to be experienced by all couples in the presence of pure liquid cesium except Mo-1/2Ti/Zr. The solubility of carbon in cesium was determined between 600° and 1200° F, and data obtained showed no effect of carbon on the freezing point of cesium. Author

**N65-13020#** Aerospace Corp., El Segundo, Calif. Material Sciences Lab.
**THERMAL EXPANSION OF BeO-SiC COMPOSITES**
W. J. Gardner 15 Oct. 1964 16 p refs
(Contract AF 04(695)-469)
(SSD-TDR-64-187; TDR-469(5250-10)-1; AD-608653)

An investigation was made of the coefficient of thermal expansion to 1000° C for composite BeO-SiC bodies. Values were found to be in general agreement with those calculated from the equation proposed by Turner, relating resultant expansion to the single component coefficients, weight fraction of the phases, phase density, and bulk modulus. Author

**N65-13035#** Polytechnic Inst. of Brooklyn, N.Y.
**EXPERIMENTAL PRESSURE, TEMPERATURE AND STRAIN MEASUREMENTS ON STAINLESS STEEL THICK-WALLED TUBES WITH INTERNAL AIRFLOW AT HIGH TEMPERATURE AND PRESSURE**
S. V. Nardo, Burton Erickson, Lawrence D. Brown, David J. Gerada, and Joseph Kempner Aug. 1964 72 p refs
(Contract Nonr-839(23))
(PIBAL-675; AD-608129)

Experimental results of pressure, temperature, and strain measurements made on a series of five Type 304 stainless-steel thick-walled tubes are presented. The tubes were subjected to a high-temperature, high-pressure internal airflow at subsonic speeds by utilizing the Mach 4.4 hypersonic wind-tunnel facility. All models were approximately 20 in. long with an internal diameter of 2.25 in.; wall thickness ranged from 0.482 to 1.0 in. Average values of the stagnation pressures and temperatures varied from 60 to 450 psia, and 1400° to 2100° R, respectively. Most of the data are presented in graphical form. Author

**N65-13037#** Massachusetts Inst. of Tech., Cambridge. Metals Processing Lab.
**DEFORMATION PROCESSING OF ANISOTROPIC METALS Progress Report, 1 Jul.–31 Aug. 1964**
D. H. Avery and W. A. Backofen Oct. 1964 5 p
(Contract NOw-65-0124-d)
(PR-7; AD-608527)

Systematic experiments on superplasticity in the 5 Al–2.5 Sn titanium alloy have been developed. Tensile tests have been made for room temperatures to 1065° C. Tensile yield strength and elongation for an initial strain rate of 0.025/minute are shown as a function of temperature. A measure of strain-rate sensitivity of the flow stress is provided by the exponent m in the empirical expression $\sigma = K\dot{\varepsilon}^m$. The temperature dependence of m is given for two different ranges of pulling speed. The data indicate the m increases with temperature in two stages characterized by a sharp rise at about 600° C to values of 0.3 to 0.4, followed by another increase to about 0.5 on approaching $\alpha$–$\beta$ transformation. Comparison of the data presented shows an excellent correlation of elongation with m up to an m of 0.3 and an elongation of 300%; further increases in m cause no further increase in elongation. P.V.E.

**N65-13040#** Battelle Memorial Inst., Columbus, Ohio. Defense Metals Information Center
**THE EFFECTS OF HEAT-TREATING AND TESTING ENVIRONMENTS ON THE PROPERTIES OF REFRACTORY METALS**
F. F. Schmidt, D. J. Maykuth, and H. R. Ogden 20 Aug. 1964 31 p refs
(Contract AF 33(615)-1121)
(DMIC-205; AD-607481)

A review of the effects of heat-treating and testing environments shows that refractory metals and their alloys are subject to contamination or purification in various test environments. The residual gases $H_2$, CO (or $N_2$), and $H_2O$ constitute the major sources of contamination when testing columbium and tantalum materials in vacua. Under the same conditions, molybdenum and molybdenum alloys containing carbon and reactive-metal additions are subject to serious decarburization. Nonreactive gaseous atmospheres also cause serious changes in material chemistry, since small quantities of noxious gases are contained in the atmosphere. Methods of circumventing material chemistry changes during various long-time, high-temperature exposures are discussed. These include (1) altering the environment by reducing pressure or increasing the purity of the nonreactive gaseous atmosphere, (2) providing a contamination barrier in the work area, (3) altering the sorption characteristics of the metal or neutralizing the environmental gases by combination with other intentionally added gases, and (4) utilizing a low-density gas flush to reduce contaminant gases in the work area. R.L.K.

**N65-13045#** Boeing Co., Seattle, Wash.
**EVALUATION OF IMPREGNATED POROUS REFRACTORY OXIDE COMPOSITES Final Report, 1 Jul. 1963–30 Jun. 1964**
F. N. Breslich, Jr. and L. M. Stejskal Wright-Patterson AFB, Ohio, AF Mater. Lab., May 1964 74 p refs
(Contract AF 33(657)-11222)
(ML-TDR-64-185; AD-607078)

A program for the evaluation of zirconia and magnesia foams impregnated with resin materials is described. The performance of various resins as ablation materials in impregnated foams was determined. A comparative evaluation of various foams impregnated with a selected resin (phenolic) was

conducted. Specimens were tested by means of an arc plasma jet, with heat fluxes to a cold wall calorimeter being 500 and 200 Btu/ft$^2$/sec for the two 10-minute tests conducted on each impregnated foam. Physical-property data for the foams were obtained, and a correlation between foam properties and performance was attempted. Improved zirconia foams were fabricated and tested. Author

**N65-13051#** United Aircraft Corp., East Hartford, Conn. Research Labs.
**INVESTIGATION OF FRACTURE MECHANISMS THERMAL STABILITY AND HOT-STRENGTH PROPERTIES OF CONTROLLED POLYPHASE ALLOYS Quarterly Progress Report No. 2, Jun. 13–Sep. 12, 1964**
James A. Ford, Byron J. Bayles, and Frederick D. George 9 Oct. 1964 23 p ref
(Contract NOw-64-0433-d)
(C-910239-2; AD-609103)

The results of continued investigations concerning the effect of phase particle size on tensile strength, thermal stability, and hot tensile strength of unidirectionally solidified Al-$CuAl_2$ and Al-$Al_3Ni$ eutectic alloys are reported. Production of sufficient ingots for all studies at three solidification rates was completed using a semiautomatic temperature controller in conjunction with a water-cooled crucible end plug. Thermal stability studies of an Al-$CuAl_2$ ingot produced at a 2.2 cm/hr solidification rate showed that 500 hr of annealing at 537° C are insufficient to cause breakdown of the lamellar structure at other than mismatch regions. Furthermore, there was no measurable change in lamellar spacing or crystallography. However, there was an increase in the number of terminations, termed faults, due to the breakdown of individual plates at defects in their surface. Author

**N65-13054#** Army Materials Research Agency, Watertown, Mass. Materials Engineering Div.
**TENSILE STRENGTH-HARDNESS RELATIONSHIPS IN THERMOMECHANICALLY TREATED STEELS**
Eric B. Kula and Albert A. Anctil Aug. 1964 23 p refs
(AMRA-TR-64-23; AD-608163) OTS: $0.50

Relationships between tensile strength and hardness have generally been developed for conventionally quenched and tempered steels. In this report, data were assembled from various sources on the strength and hardness of a number of steels after various thermomechanical treatments. These processes include the following types: (1) martensite formed from cold-worked austenite; (2) martensite formed directly during the cold working of austenite; and (3) martensite or other transformation products of austenite cold worked and aged. Steels represented include various carbon and alloy steels, as well as stainless steels. Author

**N65-13055#** Army Materials Research Agency, Watertown, Mass. Materials Engineering Div.
**THERMOMECHANICAL TREATMENTS OF THE 18% Ni MARAGING STEELS**
Eric B. Kula and Charles F. Hickey, Jr. Sep. 1964 16 p refs
(AMRA-TR-64-27; AD-608231) OTS: $0.50

Thermomechanical treatments applied to the maraging steels include (1) cold working in the austenitic condition at 650° F, followed by transformation to martensite and aging, (2) cold working in the martensitic condition and aging, and (3) cold working in the aged condition with and without subsequent re-aging. The strength increases in these steels are very small compared to the increases observed in conventional carbon and alloy steels. The changes that are observed are compatible with the strengthening mechanisms operative during thermomechanical treatment of conventional steels, however. Differences are caused by the absence of a carbide precipitate and the low work-hardening rate in both the solution-treated and the aged conditions. Author

**N65-13102#** General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation
**HIGH-TEMPERATURE MATERIALS PROGRAM. PART A Progress Report, 15 Aug.–15 Oct. 1964**
30 Nov. 1964 78 p refs
(Contract AT(40-1)-2847)
(GEMP-414) OTS: $3.00

The following investigations are reported: oxidation-resistant fuel element materials research—metallographic and electron-microprobe analyses of Fe-Cr-Al-Y-clad Cr-$UO_2$ specimens, and Fe-Cr-Al-Y alloys; high-temperature reactor materials research—stress-rupture and creep data for wrought, sintered Mo-50Re and for lap joints of Ta-10W were obtained at 1600° C in hydrogen; effect of radiation on high-temperature metals and alloys—creep-rupture testing of tungsten and molybdenum specimens, and computer studies on vacancy production in neutron-irradiated $\alpha$-iron; and high-temperature thermocouple and electrical materials research—error time due to transmutation in W/W-25Re thermocouples, and the electrical resistance of $ThO_2$ in a hydrogen atmosphere. G.G.

**N65-13121#** Battelle Memorial Inst., Columbus, Ohio. Defense Metals Information Center
**OXIDATION-RESISTANT COATINGS FOR REFRACTORY METALS Review of Recent Developments**
J. J. English 4 Dec. 1964 4 p refs

Recent developments in the following study programs are summarized: (1) the performance of refractory materials and protective coatings used in the ASSET suborbital and reentry test vehicle; (2) the Cr-Ti-Si coating system for niobium alloys; (3) the use of hafnium–tantalum alloys as protective coating materials; and (4) the use of silicide and titanium- and zirconium-modified silicide coatings for oxidation protection of tungsten. D.S.G.

**N65-13128#** Philco Corp., Blue Bell, Pa. Research Labs.
**SINGLE CRYSTAL TUNGSTEN SHEET Technical Report, 1 May–31 Aug. 1964**
L. Raymond and I. Neumann *In its* Growth of Single Crystal Tungsten to be Used for Rolling into Single Crystal Sheet [1964] 29 p refs (See N65-13126 03-15)
(U-2773) OTS: $2.00

The slip systems activated during the deformation of tungsten single crystals by rolling at 10% per pass and 1000° C were investigated by means of macroscopic dimensional changes of the billets, Laue back-reflection photographs, Vickers hardness measurements, and dislocation etch-pit techniques. For comparative purposes, both favorable and unfavorable orientations of the single crystal billets were selected. Deformation was carried to a nominal value of 50% of the original thickness. Subsize round tensile bars were machined from the sheet to measure the influence of warm working on the room-temperature mechanical properties. D.S.G.

**N65-13134#** Auburn U., Ala.
**INVESTIGATION OF MECHANISM OF FAILURE OF HIGH-STRENGTH MATERIALS. $K_{Ic}$ OF A 300-GRADE 18-NICKEL MARAGING STEEL AS INFLUENCED BY SPECIMEN TYPE AND THERMAL AND MECHANICAL TREATMENT Final Technical Report**
Hal W. Maynor, Jr. and Courtney C. Busch 31 May 1964 44 p refs
(Contract DA-01-009-ORD-889)
(FTR-3; AD-601537)

Three different type specimens were employed to determine the critical-stress intensity parameter ($K_{Ic}$) under conditions of constant specimen thickness and varying yield strength ($\sigma_{YS}$). The magnitude of the parameter was observed to vary consistently, with one exception, with specimen type. The parameter also was observed to be a discontinuous function of yield strength from the heat-treated, only, to the heat-treated-plus-cold-worked condition. The reason for the rather sharp drop in $K_{Ic}$ for center-cracked relative to surface-cracked specimens, at $\sigma_{YS}$ = 335 ksi, could not be explained. The $K_{Ic}$ of surface-cracked specimens was essentially independent of yield strength in the 297 to 335 ksi range. Author

**N65-13142*#** Martin Co., Denver, Colo.
**DETERMINATION OF LOW-TEMPERATURE FATIGUE PROPERTIES OF STRUCTURAL METAL ALLOYS Final Report, 1 Apr. 1962–30 Sep. 1964**
F. R. Schwartzberg, T. F. Kiefer, and R. D. Keys Oct. 1964 165 p refs
(Contract NAS8-2631)
(NASA-CR-59839; CR-64-74) OTS Prices: HC $5.00/MF $1.00

Two cryogenic fatigue-testing systems were constructed: one for operation at −320° F, one for −423° F testing. The equipment techniques developed demonstrated that by careful alinement, fatigue tests of axially loaded, flat sheet materials can be effectively accomplished with fully reversed stresses. Various aluminum, stainless steel, and titanium sheet alloys (0.100-in. nominal thickness) were evaluated in the parent metal and compared to notched and welded conditions (where applicable). Properties were determined at 70°, −320°, and −423°F for fatigue life in the $10^3$ to $10^7$ cycle range. The weldable aluminum alloys all showed satisfactory fatigue behavior at cryogenic temperatures. The Ti-5Al-2.5Sn and Ti-6Al-4V titanium alloys exhibited very good fatigue resistance. The 321 stainless steel showed satisfactory fatigue properties. P.V.E.

**N65-13165#** Aerojet-General Corp., Azusa, Calif. Structural Materials Div.
**STRESS-CORROSION CRACKING OF HIGH-STRENGTH ALLOYS Final Report, 1 Jul. 1963–1 Jul. 1964**
A. Rubin Aug. 1964 52 p refs
(Contract DA-04-495-ORD-3069)
(Rept.-2914; AD-604750) OTS: $3.00

Susceptibility to stress-corrosion failure was found in all 18%-nickel maraging steel alloy heats having yield strengths from 181.5 to 232.2 kilopounds per sq in. Susceptibility became greater with increasing titanium content and yield strength. At a given strength level, 18%-nickel maraging steel was less susceptible to failure than was H-11 steel or a hot-worked die steel. Cold working of 18%-nickel maraging steel before aging further reduced its susceptibility to stress-corrosion failure. Distilled water was a more severe exposure medium than 3%-salt water in causing corrosion cracking, and the U-bend test was more severe than the bent-beam test. The 18%-nickel maraging steel showed a marked increase in susceptibility to stress-corrosion cracking with an increase in environmental temperature. An inhibited epoxy coating designated as 454-1-1 was very effective in greatly delaying stress-corrosion cracking both of maraging steels and of H-11 steel. D.E.W.

**N65-13184#** Battelle Memorial Inst., Columbus, Ohio.
**FURTHER DEVELOPMENT OF A DUCTILE TUNGSTEN-BASE SHEET ALLOY Quarterly Progress Report, 19 May–19 Aug. 1964**
J. L. Ratliff, W. H. Abbott, D. J. Maykuth, H. R. Ogden, J. M. Blocher et al 19 Sep. 1964 26 p refs
(Contract N600(19)-61982)
(QPR-1; AD-449949)

Scale-up feasibility was demonstrated for the W-5Re-2.2$ThO_2$ alloy. Starting with a thickness of 1/2 inch, a section of this alloy was rolled at 1600° C through a total reduction of 92% to 0.040-inch-thick sheet. An evaluation of this sheet material showed a recrystallization temperature of 2000° C and 4T bend ductility at room temperature for the stress-relieved condition. Low temperature tensile tests on the alloy showed 12% elongation and 18% reduction of area at 0° C. Additional studies are also being conducted in an effort to develop improved techniques for dispersing thoria in W-5Re. As a separate part of this program, three selected forms of pyrolytic tungsten are to be evaluated as sheet material. Procurement and/or preparation of sheet bars of these is in process. Author

**N65-13191#** Rensselaer Polytechnic Inst., Troy, N.Y.
**THE THERMODYNAMICS OF CORROSION IN MOLTEN CARBONATES: APPLICATION OF E-p$CO_2$ DIAGRAMS**
M. D. Ingram and G. J. Janz Oct. 1964 27 p refs Submitted for Publication
(Contract Nonr-591-(10))
(TR-23; AD-449958)

The corrosion of metals in fused carbonates is discussed in terms of a diagrammatic presentation of the thermodynamic data. The treatment closely resembles that of Pourbaix and Littlewood; diagrams are plotted of E vs p$CO_2$, where E is the redox potential of the system, and p$CO_2$ = $-\log_{10}(CO_2)$. Each diagram is divided into three regions that mark the limits of stability at unit activity of the pure metal, metal oxide, and liquid metal carbonate. In the oxide region the metal may become passivated, but this depends on structural factors and requires experimental confirmation. The electrochemical series in molten carbonates is presented, and the significance of p$CO_2$ in relation to acid-base behavior is discussed. Author

**N65-13225*#** Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile Space Systems Div.
**EVALUATION OF MARAGING STEEL FOR APPLICATION TO SPACE LAUNCH VEHICLES Supplementary Report**
M. V. Mixon, F. T. Wimmer, and Z. P. Saperstein May 1964 36 p refs
(Contract NAS7-214)
(NASA-CR-59880; SN-43105) OTS Prices: HC $2.00/MF $0.50

The principal objective of this investigation was to differentiate between the effects of retained austenite and titanium nitride inclusions on 18Ni-7Co-5Mo maraging weld-metal fracture toughness. Previously, it had been shown that normally aged weld metal was characterized by an austenitic network laden with TiN. Weld-metal fractures propagated through these networks preferentially, and resulted in fracture toughness properties that were substantially inferior to parent plate.

The results of the present investigation demonstrated that the TiN inclusions alone (i.e., independent of the surrounding austenitic islands) were the primary cause of impaired toughness. This was determined by employing thermal treatments that eliminated austenite while leaving the nitrides substantially unaffected. Author

**N65-13232#** Texaco Experiment Inc., Richmond, Va.
**NON-EQUILIBRIUM COMBUSTION Quarterly Progress Report, 15 Jun.–14 Sep. 1964**
12 Oct. 1964 12 p refs
(Contract N600(19)-58555)
(EXP-401; TM-1588; AD-447656)

A combination manometric and volumetric system has been constructed for determining the oxidation rates of both solid and molten aluminum. Preliminary experiments indicate that the sensitivity and accuracy of the system are adequate for the present study. A number of runs have been made using aluminum foil at 600° C. Although the actual oxidation rates were not reproducible, the total amount of oxygen consumed was approximately the same in all cases. The inconsistency in the results confirms the findings of Cochran and Sleppy; i.e., oxidation rates depend greatly on the way the surface is originally treated. This is apparently true even in the case of molten aluminum. Aluminum foil, at 600° C, gained approximately 5.2$\mu$gm/cm$^2$ as compared with approximately 5.7$\mu$gm/cm$^2$ reported by Cochran and Sleppy or 5.0$\mu$gm/cm$^2$ reported by Blackburn and Gulbransen. Initial experiments with molten aluminum indicate much higher weight gains than those obtained with aluminum foil. Author

**N65-13242#** Army Materials Research Agency, Watertown, Mass. Material Engineering Div.
**ACTION OF SODIUM CITRATE AND SODIUM BORATE ON THE POLARIZATION CHARACTERISTICS OF A URANIUM-STEEL COUPLE**
Milton Levy and Philip Wong Oct. 1964 16 p refs
(AMRA-TR-64-33; AD-608343) OTS: $0.50

The action of sodium citrate and sodium borate in aqueous media on the polarization characteristics of uranium and steel was studied. The effect of citrate and borate concentration on these polarization characteristics was also studied. Steady-state corrosion currents developed by the uranium–steel couple were measured using zero-resistance ammeter circuitry, and polarization measurements were made using galvanostatic techniques. Sodium citrate and sodium borate were classified as either accelerator or inhibitor, dependent upon concentration. Author

**N65-13274*#** Ohio State U. Research Foundation, Columbus. Antenna Lab.
**THE STATIC RESPONSE CHARACTERISTICS OF A CARBON BOLOMETER ELEMENT**
Glenn G. Shephard (M.S. Thesis), 15 Oct. 1964 32 p refs *Its* Rept.-1093-21
(Grant NsG-74-60)
(NASA-CR-59912) OTS Prices: HC $2.00/MF $0.50

The electrical resistivity of carbon resistor material has been experimentally determined as a function of temperature and has been used to calculate the static response characteristics of a particular carbon bolometer element without making use of the usual isothermality and constant thermal-conductivity assumptions. Author

**N65-13282*#** General Electric Co., Philadelphia, Pa. Space Sciences Lab.
**THE SYNTHESIS OF BORON CARBIDE FILAMENTS Final Report**
A. Gatti, R. Cree, E. Feingold, and R. Mehan Jul. 1964 64 p refs
(Contract NASw-670)
(NASA-CR-59907) OTS Prices: HC $3.00/MF $0.75

$B_4C$ whiskers are grown best by evaporation from pure $B_4C$ vapor; they are also grown by a chemical method based on the flow of appropriate gases over a heated substrate. The largest whiskers average 1 cm in length. A major effort was to measure the room-temperature properties of representative whiskers. The strongest crystal supported stress of 965 000 psi in tension. Modulus value of about $65 \times 10^6$ psi was determined. Studies on morphology, orientation, crystal structure, etc. of $B_4C$ whiskers are reported. Only the "A" whiskers were found. Wetting studies conducted in vacuum and hydrogen atmospheres screened metal for metal-$B_4C$ composite fabrication. Fernico "5" was the choice for future work. Epoxy-based composites were fabricated and tested in tension. A factor of four in strengthening was achieved with short fiber reinforcement. A tensile value of 24 700 psi was measured for a 10 volume percent composite. Unreinforced epoxy averaged 6000 psi in tension. Author

**N65-13298#** Battelle Memorial Inst., Columbus, Ohio. Defense Metals Information Center
**HIGH-STRENGTH STEELS Review of Recent Developments**
H. J. Hucek and T. P. Groeneveld 16 Oct. 1964 4 p refs
16 Oct. 1964 4 p refs

The following topics are presented: "Kinetics and Mechanism of Strengthening Maraging Steels"; "Unidirectional Solidification of High-Strength Steel"; "Variations in Yield Strength of Maraging Steels with Variations in Composition"; "Spheroidizing of 4340 Steel"; "9Ni-4Co Alloy Steels"; "Possible HY-130/150 Submarine-Hull Steel"; "180 000 to 210 000-PSI Yield-Strength Maraging Steels"; and "Elevated-Temperature and Notch-Strength Properties of 18Ni (250) Maraging Steel." G.G.

**N65-13304#** Boeing Scientific Research Labs., Seattle, Wash. Solid State Physics Lab.
**THE DISLOCATION DISTRIBUTION IN FACE CENTERED CUBIC METALS AFTER FATIGUE**
Regis M. N. Pelloux Oct. 1963 65 p refs
(DI-82-0304)

The dislocation distribution in fatigued metals was studied by transmission electron microscopy in aluminum, copper, and 70-30 brass. In aluminum and copper where cross-slip is easy, the dislocations are arranged in tangles and clusters of elongated dislocation loops. In 70-30 brass the dislocations are uniformly distributed throughout the grains, with a large amount of dislocation debris (small loops, short jogged dislocation segments) and long rows of dislocation dipoles. The different mechanisms of formation of dislocation jogs, elongated loops, dislocation tangles, and dipole clusters are reviewed successively. The interaction between moving dislocations and elongated loops is facilitated by easy cross-slip, thus leading to the formation of dense dipole clusters in high stacking fault energy metals. In low stacking fault energy metals, rows of dipoles are created by interaction of dislocations of opposite signs on neighboring slip planes. The large density of dislocation dipoles explains the absence of lattice distortions in fatigued metals. Author

**N65-13321#** Westinghouse Electric Corp., Pittsburgh, Pa. Astronuclear Lab.
**PILOT PRODUCTION AND EVALUATION OF TANTALUM ALLOY SHEET Quarterly Report No. 8, Apr. 28–Jul. 28, 1964**
R. L. Ammon and R. T. Begley 1 Sep. 1964 20 p refs
(Contract NOw-64-0394-d)
(WANL-PR-M-010; AD-607102)

This report describes the investigation of the processing procedures used to convert T-222 from arc-cast ingot to sheet. The effects of prior reduction, of the number and temperature of intermediate anneals, and of the temperature of the final anneal were evaluated with respect to 2400° F tensile properties. Preliminary results indicated that intermediate and final annealing temperature had a significant effect on tensile properties. Author

**N65-13340#** Thompson Ramo Wooldridge, Inc., Cleveland, Ohio. Electromechanical Div.
**FRACTURE CHARACTERISTICS OF STRUCTURAL METALS Second Quarterly Progress Report, Apr. 22–Jul. 22, 1964**
M. F. Amateau and E. A. Steigerwald 15 Aug. 1964 58 p refs
(Contract NOw-64-0186-c)
(ER-5937-1; AD-604570) OTS: $3.00

The purpose of this program is to evaluate the use of plane strain fracture toughness $K_{IC}$ as a possible parameter for handbook application. During this report period, a literature survey dealing with the assembly of pertinent $K_{IC}$ data has been continued. The experimental effort has involved the determination of plane strain fracture toughness in specimens taken from 8-inch square forged billets of H-11 and 4340 steels. The results indicate that $K_{IC}$ did not vary significantly as a function of specimen position within the billet. The room temperature $K_{IC}$ parameter for AM 355 steel at aging temperatures between 850° and 1025° F was evaluated. Author

# 18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

**N65-12497#** Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
**STUDY OF RESIDUAL STRESSES IN THICK GLASS FILAMENT REINFORCED LAMINATES Quarterly Progress Report No. 1, 30 Jun.–30 Sep. 1964**
F. E. Stone and L. B. Greszczuk 30 Sep. 1964 80 p refs
(Contract NObs-90301)
(SM-47728; AD-606406) OTS: $4.00

The purpose of this study is to determine the presence and magnitude of residual stresses in thick wall Fiberglas structures, and their effect on material properties. This information will be applicable to full-size deep-submergence structures, and detrimental effects may be minimized or eliminated. Theoretical investigations, analysis methods, fabrication, and test results to date are presented and related to each other in this report. Test results thus far have been restricted to hoop wound rings, from which residual circumferential stresses have been recorded as high as 19 000 psi. Author

**N65-12623*#** Mellon Inst., Pittsburgh, Pa.
**VISCOELASTIC BEHAVIOR OF POLYMERS AT LONG TIMES Seventh Semiannual Report, Period Ending 31 Oct. 1964**
Donald J. Plazek 10 Nov. 1964 6 p
(Grant NsG-147-61)
(NASA-CR-59761) OTS Prices: HC $1.00/MF $0.50

Investigations of polymer behavior are continuing in the following areas: (1) the nature of the dispersion in crosslinked systems in the rubbery behavior region in which the molecular weights between the entanglement points $M_e$ and between the primary chemical crosslinks $M_c$ appear to be the pertinent characterizing parameters, and in which $M_c$ seems to be reflected in the Andrade creep intercept at zero time; (2) the character of the response of linear amorphous polymers, particularly polyvinylacetate, in relation to time–temperature dependences of the mechanisms giving rise to the glass-to-rubber transition and those responsible for dispersion in the rubber-like plateau and beyond; and (3) the viscoelastic response of a nonpolar, small molecule compound in the neighborhood of its glass temperature as exemplified by 1, 3, 5-tri-α-naphthyl benzene. An abstract of a paper giving the results of the third study is included. M.P.G.

**N65-12630#** Forest Products Lab., Madison, Wis.
**STRENGTH PROPERTIES OF REINFORCED PLASTIC LAMINATES AT ELEVATED TEMPERATURES (VIBRIN 135 RESIN AND 181-GARAN GLASS FABRIC)**
Kenneth H. Boller Wright-Patterson AFB, Ohio, AF Mater. Lab., Aug. 1964 46 p refs
(Contract AF 33(657)-63358)
(ML-TDR-64-167; AD-606767)

Several reinforced plastic laminates that show promise of having good strength properties at elevated temperatures are being evaluated to determine their strength and elastic properties. Flexure, tension, compression, interlaminar shear, and bearing tests parallel to the warp direction are made to determine the effects of high temperature and duration of exposure on the strength properties. Tension tests at 45° to the warp direction are made to obtain data from which edgewise shear strength and modulus of rigidity can be calculated. Creep and stress-rupture data are obtained under both tensile and compressive loads. In addition to strength properties, data are obtained on weight loss of the laminated material during exposure. Author

**N65-12921#** Massachusetts U., Amherst. Polymer Research Inst.
**DYNAMIC DICHROISM OF DYED POLYMER FILMS II**
R. Yamada and R. S. Stein Aug. 1964 12 p refs
(Contract Nonr-3357(01))
(ONR-TR-73; AD-607107)

The study of the time-dependence of visible dichroism of dyed polymers is described. Through measurements of the total orientation by birefringence, attempts were made to resolve orientation into crystalline and amorphous components. Other rheo-optical studies showed that the time dependence of crystalline and amorphous orientation should be different, and that this difference should result in different time dependencies for dichroism and for birefringence. Preliminary measurements were made of the variation, with strain and time, of

dichroism of congo-red-dyed polyvinyl alcohol and nylon-6. It was observed that the dichroism does not vary with time and elongation in the same way as birefringence, suggesting that different portions of the polymer structure contribute to these two experiments. D.E.W.

**N65-13011#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**NEW IRON-CONTAINING POLYMERS ON THE BASIS OF FERROCENE AND THEIR ELECTROPHYSICAL PROPERTIES**
Ya. M. Paushkin, L. S. Polak, T. P. Vishnyakova, I. I. Patalakh, F. F. Machus et al 19 Oct. 1964 12 p refs Transl. into ENGLISH from Vysokomol. Soedineniya (USSR), v. 6, no. 3, 1964 p 545–550
(FTD-TT-64-773/1+2; AD-608051)

On the basis of ferrocene and its derivatives 14 new polymers were obtained by polyrecombinations and condensation polymerizations. The polymers represent polyconjugative systems and possess electrical resistances from $1 \cdot 10^{12}$ to $1 \cdot 10^{9}$ cm·ohm and activation energy from 0.3 to 1.74 eV. An energy transfer from the valence zone into the conductivity zone of the macromolecules of the polymer of 1,1'-diacetylferrocene was obtained through the excitation of the π-electrons. This took place, basically, by surface adsorption. G.G.

**N65-13057#** California Inst. of Tech., Pasadena.
**MULTIAXIAL FAILURE OF VISCOELASTIC MATERIALS**
A. R. Zak Wright-Patterson AFB, Ohio, ARL, Sep. 1964 82 p refs
(Contract AF 33(616)-8399)
(ARL-64-144; AD-608447)

A new engineering failure theory is developed and described. This theory takes into consideration general, multiaxial, viscoelastic loading conditions. A viscoelastic stress analysis of the poker-chip specimen is presented. In the experimental failure studies the Solithane 113 polymer material is being used. This material is being made and cured in the laboratory in a specially constructed facility. This facility and the manufacturing process are described in detail. The experimental program and the data obtained are presented. Two types of tests are described, the uniaxial and the triaxial. The uniaxial test is conducted at various constant strain rates and temperatures. The triaxial test uses the poker-chip specimen and generates failure data under triaxial-stress conditions. Author

**N65-13239#** Aberdeen Proving Ground, Md. Coating and Chemical Lab.
**ADHESION OF SPECIFICATION FINISHES TO EPOXY RESIN PRIMER MIL-P-52192 (ORD)**
John A. Rakaczky 8 Sep. 1964 14 p refs
(CCL-167; AD-608133) OTS: $0.50

A study was made to determine the factors that might affect the intercoat adhesion between specification finishes and epoxy resin primer MIL-P-52192. It was determined that the migration of unreacted amine to the surface of air-dried epoxy primer films could adversely affect intercoat adhesion when subjected to accelerated laboratory tests. However, there was no evidence of this on systems subjected to 2 1/2 years exterior exposure. To minimize the possibility of intercoat adhesion problems the following recommendations are made: (1) Apply the finish coat within 4 hours after application of primer. (2) If the finish coat cannot be applied within 4 hours, the primer should be given a light sanding immediately prior to painting. (3) If possible bake the primer for one hour at 300° F. Author

**N65-13240#** Aberdeen Proving Ground, Md. Army Coating and Chemical Lab.
**ORGANO-SILICONE SURFACTANTS IN ALKALINE CLEANERS Final Report**
A. Mankowich 2 Oct. 1964 17 p refs
(CCL-169; AD-608410)

Organosilicone surfactants impart very high surface-tension depressing characteristics, but in themselves are not good cleaners. When used with other surfactants such as sodium lauryl sulphate or sodium dodecyl benzene sulphonate, a cleaner can be developed equal to federal-specification formulas. Present costs would not permit general use of the organosilicone surfactants for this purpose. Author

# 19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

**N65-12422*#** General Electric Co., Philadelphia, Pa. Space Sciences Lab.
**APPLICATION OF NON-LINEAR REGRESSION ANALYSIS AND OF ANALYSIS OF VARIANCE TO THE DETERMINATION OF PERIODS OF EVENTS DEFINED BY IRREGULARLY SPACED OBSERVATIONS**
I. Jurkevich 2 Nov. 1964 50 p refs
(Contract NASw-880)
(NASA-CR-59694) OTS Prices: HC $2.00/MF $0.50

Methods were developed for the determination of accurate periods of periodic events observed at irregular intervals of time; time-series analysis developed for equally spaced data becomes too restrictive when such spacing cannot be produced. Two approaches were selected for study—the first based on the iterative harmonic analysis of observations, and the second based on analysis of variance technique for a single variable. Both methods were tested numerically against short runs of real data, and were found to work in principle. From the computational point of view, the latter approach was preferable because of significant economy and speed. However, it requires that the available data record extend over several periods. The harmonic analysis approach yields useful results with data covering intervals not much longer than a full period. This gain is achieved at the expense of computational simplicity. D.S.G.

**N65-12447#** Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
**A MULTIPLE-ASSIGNMENT PROBLEM Mathematical Research Note No. 347**
David W. Walkup and M. Donald Mac Laren Apr. 1964 17 p refs
(DI-82-0346)

A generalization of Kuhn's simple assignment problem is considered: There are m men and n tasks given, with each man qualified for certain tasks. The output from each task is given as a concave function of the number of qualified men assigned to it. The problem is to find an assignment of men to tasks, perhaps more than one man to a task, to maximize total output. An algorithm for solving this general problem is given, in which transfers like those used by Kuhn for a simple problem are selected, by using a node-labeling procedure on a related network. The algorithm yields for every k, $1 \leq k \leq m$, an optimal

assignment of the first k men only, employing a single transfer to increase k by one. Several special forms of the generalized problem are considered, including a target-assignment problem, which was formulated as a linear program. Author

**N65-12473*#** RAND Corp., Santa Monica, Calif.
**RELIABILITY GROWTH DURING A DEVELOPMENT TESTING PROGRAM**
Richard E. Barlow and Ernest M. Scheuer Nov. 1964 22 p refs
(Contract NASr-21(09))
(NASA-CR-59735; RM-4317-NASA) OTS Prices: HC $1.00/MF $0.50

The study proceeds on the supposition that the test program is conducted in K stages, with similar items being tested within each stage. For each stage, the number of inherent failures, of assignable cause failures, and the number of successes is recorded. It is supposed that the probability of an inherent failure, $q_0$, remains the same throughout the test program, and that the probability of an assignable cause failure in the ith stage, $q_i$, does not increase from stage to stage of testing. This memorandum obtains maximum likelihood estimates of $q_0$ and of the $q_i$'s subject to the condition that they be nonincreasing, and also obtains a conservative lower confidence interval for $r_K$, the reliability of the system in its final configuration of the test program. Numerical examples to illustrate these methods are given. Author

**N65-12514#** Wisconsin U., Madison.
**A NOTE ON PARTIAL DUPLICATION OF DESIGNS**
George E. P. Box Jan. 1964 5 p refs
(Contract Nonr-1202(17))
(TR-24; AD-604261)

A simple and general procedure is presented for estimating the effects, variances, and covariances of the augmented arrangements that result from particular schemes of partial duplication. The sequential use of two-level fractionals as building blocks is applied in estimates where the expected values contain common effects and may be combined, by the application of the weighted least-square theory, with those individual estimates used as observations. G.G.

**N65-12524#** RAND Corp., Santa Monica, Calif.
**ON THE COMPUTATIONAL SOLUTION OF A CLASS OF FUNCTIONAL DIFFERENTIAL EQUATIONS**
Richard Bellman and K. L. Cooke Oct. 1964 16 p refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-4287-PR; AD-606987)

Functional differential equations of the form

$$u'(t) = g(t,u(t),u(h(t))), \tag{1}$$

and, more generally, of the form

$$u'(t) = g(t,u(t),u(h(u,t))), \tag{2}$$

arise in the construction of realistic models in a number of fields, ranging from electromagnetic theory and control theory to respiratory theory and neurophysiology. In this paper, a method for the computational treatment of differential-difference equations is extended to cover equations of the form given in (1). Equations of the type appearing in (2) can then be treated by means of successive approximations. Author

**N65-12582#** Aerospace Corp., San Bernardino, Calif. Computation and Mathematics Center
**RELIABILITY COST/EFFECTIVENESS. A PILOT STUDY Final Report**
S. H. Brooks Jun. 1964 42 p refs
(Contracts AF 04(695)-269; AF 04(695)-469)
(BSD-TDR-64-91; TDR-269(S4853)-1; AD-451906)

A mathematical model is developed and explored to examine the overall relationship between the effectiveness—in terms of reliability, availability, and maintainability—and the costs to be allocated and apportioned among the reliability efforts. This model leads to an estimate of how much should be spent on reliability during design and development of a missile system, and how much should be spent in ensuring the reliability and availability for each individual missile during its operational life. A computer program was developed, and parameter studies along these lines were initiated. Requisite optimization and information methods are discussed. Preliminary indications are that cost–effectiveness modeling is feasible and leads to methods of program control. Author

**N65-12597*#** Martin Co., Baltimore, Md. RIAS Div.
**ON DYNAMICAL SYSTEMS IN THE PLANE**
Peter Seibert and Patricia Tulley (Maryland U.) 1964 6 p ref
(Contracts NASw-845; AF 49(638)-1242; Nonr-3693(00))
(NASA-CR-59716) OTS Prices: HC $1.00/MF $0.50

A simpler proof than that given by Bohr and Fenchel is presented for the following theorem: If (X,T) is a transformation group, T is the additive group of real numbers, X is a subspace of the plane, and x is a point of X such that $xt \neq x$ for $t \neq 0$, then $\gamma(x)$, the orbit of x, is not recurrent. M.P.G.

**N65-12599*#** Martin Co., Baltimore, Md. RIAS Div.
**ON GENERALIZED DYNAMICAL SYSTEMS DEFINED BY CONTINGENT EQUATIONS**
Emilio O. Roxin [1963] 31 p refs
(Contracts NASw-845; AF 49(638)-1242; Nonr-3693(00))
(NASA-CR-59753) OTS Prices: HC $2.00/MF $0.50

The problem of how a contingent equation defines a generalized dynamical system is considered, and new existence and uniqueness theorems are given as examples. The state variables are considered as points of the real n-dimensional euclidian space, which is considered as a vector space over the real numbers for this problem. G.G.

**N65-12600*#** Martin Co., Baltimore, Md. RIAS Div.
**STABILITY IN GENERAL CONTROL SYSTEMS [STABILITAT IN ALLGEMEINEN REGELUNGSSYSTEMEN]**
Emilio O. Roxin [1963] 12 p refs In GERMAN
(Contracts NASw-845; AF 49(638)-1242; Nonr-3693(00))
(NASA-CR-59755) OTS Prices: HC $1.00/MF $0.50

The transfer of various degrees of stability concepts from an ordinary dynamic system onto a control system is demonstrated. Considered are the definitions for a general control system with a strong form of stability, and also for a control system with a weak form of stability. G.G.

**N65-12602#** Joint Publications Research Service, Washington, D.C.
**A METHOD FOR THE SYNTHESIS OF GRAPH-DIAGRAMS OF ALGORITHMS**

A. Sh. Blokh and G. S. Neverov 11 Dec. 1964 7 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Belorussk. SSR v. 8, no. 9, Sep. 1964 p 568–571
(JPRS-27805; TT-64-51922) OTS: $1.00

A formal method is presented that uses language-of-characteristics tables to synthesize the graphs and diagrams of the algorithms of a class of tactical problems. The application of this method in the digital computer analysis simplifies the algorithms, substantially shortens the programing time, and creates the prerequisites for automating the programing of tactical problems. G.G.

**N65-12649#** Joint Publications Research Service, Washington, D.C.
**ON ALGORITHMS THAT CAN BE EFFECTIVELY REALIZED BY COMPUTER SYSTEMS**
G. A. Bekishev 18 Dec. 1964 16 p refs Transl. into ENGLISH from Vychislitel'nyye Sistemy (Novosibirsk), no. 7, 1963 p 24–37
(JPRS-27906; TT-64-51969) OTS: $1.00

The efficiency of algorithms for problem solving is discussed from the viewpoint of hardware and time requirements. The most efficient algorithms for problem solving are considered to be those that can be realized with a minimal number of machines and computations. Working from this point of view, the problem of adding and multiplying n numbers and the problem of raising a number to a natural power are considered in detail. P.V.E.

**N65-12657#** RAND Corp., Santa Monica, Calif.
**THE HOMOLOGY GROUPS OF A LATTICE**
Jon Folkman Oct. 1964 15 p refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-4253-PR; AD-606997) OTS: $1.00

Rota has defined homology groups for certain subsets, called crosscuts, of a lattice. He showed that the value of the Euler characteristic associated with this homology theory depends only on the lattice, not on the choice of the crosscut. It was conjectured that the homology groups themselves depend only on the lattice. In this paper Rota's conjecture is proven. Using this result, the structure of the homology groups is determined for an important class of lattices called geometric lattices. Author

**N65-12668#** Joint Publications Research Service, Washington, D.C.
**EFFICIENT SOLUTION OF VERY SIMPLE PROBLEMS IN MATRIX ALGEBRA BY MEANS OF COMPUTER SYSTEMS CONTAINING L MACHINES**
G. A. Bekishev 18 Dec. 1964 31 p refs Transl. into ENGLISH from Vychislitel'nyye Sistemy (Novosibirsk), no. 9, 1963 p 3–29
(JPRS-27907; TT-64-51970) OTS: $2.00

This article considers algorithms for parallel-processing solution of basic problems on matrix operations, i.e., algorithms for computer realization. The problem of optimal algorithms of this type is investigated. Assuming that parallel execution of operations is possible during solution of a given matrix problem, the problem of the minimal number h of computation steps required for solution of a given problem is stated. Also considered is the minimal number of machines required for solution of a given problem in h computation steps, a problem that is closely related to the problem of calculating the minimum number of required steps. We have formulated all problems as problems of finding optimal algorithms. Author

**N65-12674#** Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
**UNIFORM RANDOM NUMBER GENERATORS**
M. Donald Mac Laren and George Marsaglia Apr. 1964 18 p refs *Its* Math. Note No. 349
(DI-82-0349)

Discussed are the testing of methods for generating uniform numbers in a computer, including the commonly used multiplicative and mixed congruential generators, as well as two new methods. Tests proposed in this paper are more stringent than those usually applied, because the usual tests for randomness have passed several of the commonly used procedures that subsequently gave poor results in actual Monte Carlo calculations. The principal difficulty seems to be that certain simple functions of n-tuples of uniform random numbers do not have the distribution that probability theory predicts. Two alternative generating methods are described—one using a table of uniform numbers, and the other combining two congruential generators. Both of these methods passed the tests, whereas the conventional multiplicative and mixed congruential methods did not. Author

**N65-12675#** Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
**UTILITY FUNCTIONS AND THE "lin" OPERATION FOR CONVEX SETS**
Victor Klee Oct. 1964 17 p refs *Its* Math. Note No. 371
(DI-82-0381)

An X-dimensional preference relation is a transitive and reflexive relation on an X-dimensional real linear space E such that the following conditions are satisfied for all x, y, and $x \in E$: (1) if $x \gtrsim y$, then $x + z \gtrsim y + z$; (2) if $x \gtrsim y$ and $\gamma > 0$, then $\gamma x \gtrsim \gamma y$; and (3) if $x \gtrsim kz$ for all positive integers k, then not $z \gtrsim 0$. The fact that the weak archimedean principle [condition number (3)] is not sufficient for the existence of a utility function is substantiated. When X is a convex subset of a linear space E, let there be defined the order of X (ord X) as the smallest ordinal number $\alpha$ such that $\text{lin}^{\alpha} X = \text{lin}^{\beta} X$ for all $\beta > \alpha$, and the level of X (lev X) as the set of all ordinal numbers $\beta$ such that there exists a convex set C with $\text{lin}^{\beta} C = X$ but $\text{lin}^{\alpha} C \neq X$ if $\alpha < \beta$. A simple proof is given to show that if dim $E = X_0$ then every countable ordinal is realized as ord X for some convex $X \subset E$. P.V.E.

**N65-12741#** Joint Publications Research Service, Washington, D.C.
**CERTAIN PROBLEMS ON CONTROLLED PROBABILITY PROCESSES**
A. A. Borovkov 9 Dec. 1964 17 p refs Transl. into ENGLISH from Sibirskiy Mat. Zhur. (Novosibirsk), v. 5, no. 5, 1964 p 996–1006
(JPRS-27766; TT-64-51900) OTS: $1.00

Problems that are of interest in the theory of mass or public services are considered. Several theorems and lemmas are proved in each of two sections entitled "Controlled Wandering" and "Process Being Controlled by Wandering." D.E.W.

**N65-12807*#** Auburn Research Foundation, Inc., Ala.
**DIGITAL FILTERS**
Edward B. Anders, James J. Johnson, Alfred D. Lasaine, Paul W. Spikes, and James T. Taylo Washington, NASA, Dec. 1964 140 p refs
(Contract NAS8-5164)
(NASA-CR-136) OTS Prices: HC $2.75/MF $1.00

Digital (numerical) filtering techniques have become significant methods for data processing. This report presents the necessary background theory for a large class of digital filters. Particular filters discussed are those for smoothing, smoothing and first derivative, smoothing and second derivative, and smoothing and integration. Error bounds are given for the first three types. Author

**N65-12864#** SAAB Aircraft Co., Linkoping (Sweden).
**ON THE SEMI-MARKOV PROCESS AND ITS BLOCK DIAGRAM REPRESENTATION WITH APPLICATIONS TO AIRCRAFT MISSION ANALYSIS**
Lars Kristiansson Mar. 1964 18 p refs
(SAAB-TN-55)

The semi-Markov process is defined as a stochastic process in which time is the independent variable and the dependent variable can assume only an enumerable number of discrete values (states), and where transition from one given state to another depends on the length of time spent in the given state. Provided the process is described with the aid of frequency functions $d_j(t)$ that specify the probability of a certain state j being reached in the time interval (t; t+ $\Delta$t), simple process equations are obtained. These equations can be represented by means of block diagrams. There is perfect correspondence between the process and the electrical network with positive feedback. The utility of the process is illustrated by means of an example concerned with aircraft mission analysis. Author

**N65-12865#** College of Aeronautics, Cranfield (Gt. Brit.)
**THE SYNTHESIS OF A DYNAMICAL MODEL OF A TIME-VARYING LINEAR SYSTEM**
R. J. A. Paul and A. J. Martin Jun. 1964 23 p refs
(CoA-E&C-1)

Experimental techniques are described for the simulation of a model of a linear system having a transmission transfer function whose parameters are subject to wide variations from their nominal values but in a time that is long compared with the measurement time. The simulation is based on the use of orthogonal functional approximations described previously. It is confirmed that if only one pole of the system changes significantly, during the period of measurement, then a unique result is obtained for an exact simulator model of the system. It is also demonstrated that a good approximation to a system, in which three poles change simultaneously from their nominal values, is obtained by adopting a hill-climbing or iterative technique. Author

**N65-12896#** Naval Ordnance Lab., Corona, Calif. Fuze Dept.
**LEAST SQUARES SURFACE FITTING WITH EQUAL ADJUSTMENTS FOR ONE INDEPENDENT VARIABLE IN A SUBSET OF THE DATA, JULY–AUGUST 1963**
A. P. Boblett 1 Oct. 1964 17 p ref
(NAVWEPS-8207; AD-449526)

To determine the function connecting the sensitivity of an explosive composition with loading pressure and the percent of inert material, a surface fitting technique has been derived for data in which one independent variable is uniform for a subset of the data. The method of derivation consists of supplementing the usual set of condition equations with an additional set that forces the adjusted values of the independent variable to have a common value throughout the subset. The resulting general normal equations are derived and solved for the adjustments in the unknown parameters, as well as for the adjustments in the unconstrained and constrained variables. This method can also be applied to a wide variety of test situations. Author

**N65-12906#** State U. of New York, Stony Brook.
**THE DISTRIBUTIONAL LAPLACE AND MELLIN TRANSFORMATIONS Fourth Scientific Report**
A. H. Zemanian 16 Aug. 1964 85 p refs *Its* Rept.-26
(Contract AF 19(628)-2981)
(AFCRL-64-685; AD-608099)

A new definition for the distributional two-sided Laplace transformation $L$ is devised as follows. Let t be a one-dimensional real variable. Spaces of testing functions on $-\infty < t < \infty$ are constructed, which contain exponential functions $e^{-st}$, s being a complex parameter. Their dual spaces turn out to be subspaces for the space $D'$ of distributions. Then, for any f in such a subspace, $Lf$ is defined as the application of f to $e^{-st}$,

$$Lf = < f, e^{-st} >.$$

The distributional Mellin transform of a distribution on $0 < X < \infty$ is analogously defined as

$$< f, x^{s-1} >,$$

where $x^{s-1}$ is a member of a certain space of testing functions on $0 < X < \infty$ and f is in the dual space. These ideas are developed for the case where t and x are n-dimensional. Author

**N65-12936#** Brown U., Providence, R.I.
**A FUNCTION SPACE APPROACH TO THE IDENTIFICATION OF LINEAR SYSTEMS. PART I: FORMULATIONS FOR TIME INVARIANT AND TIME VARYING SYSTEMS**
A. E. Pearson Oct. 1964 17 p refs
(NSF GP-3060)

The identification of the kernel function matrix for a multiple input-output linear system is considered in the context of solving a linear operator equation in a Hilbert space. Formulations are reported for time invariant and time-varying systems in the mathematical representation of the measured input and output transient data. The class of input signals is unrestricted; however, the transient data are assumed to be uncorrupted by noise due to the measuring instruments. Author

**N65-12937#** Brown U., Providence, R.I.
**A FUNCTION SPACE APPROACH TO THE IDENTIFICATION OF LINEAR SYSTEMS. PART II: ON THE UNIQUENESS AND CONSTRUCTION OF SOLUTIONS**
A. E. Pearson Oct. 1964 21 p refs
(NSF GP-3060)

Necessary conditions are investigated for the uniqueness of solutions to the identification problem. The conditions refer to the linear independence of various vector-valued functions that depend only upon the measured input data. Iterative techniques are indicated that may be used to compute the kernel function matrix from the given input and output transient data.

The techniques are drawn from the various approximate methods that have been developed for solving operator equations in a Hilbert space. Author

**N65-12943#** RAND Corp., Santa Monica, Calif.
**ON THE IDENTIFICATION OF SYSTEMS AND THE UNSCRAMBLING OF DATA-I: HIDDEN PERIODICITIES**
R. E. Bellman, H. H. Kagiwada, and R. E. Kalaba Sep. 1964 9 p refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-4285-PR; AD-606254)

A general problem of great interest in science and control engineering is that of identifying a system on the basis of observations. It is shown how to view this as a nonlinear multipoint boundary-value problem that can be resolved numerically by using the method of quasi-linearization. This paper is devoted to the hunt for hidden periodicities in data and provides an attractive alternative to the classical periodogram analysis. Author

**N65-12981#** New York U., N.Y. Courant Inst. of Mathematical Sciences
**STABILITY STUDIES FOR DIFFERENCE EQUATIONS. I: NON-LINEAR STABILITY. II: COUPLED SOUND AND HEAT FLOW**
R. D. Richtmyer and K. W. Morton 25 Aug. 1964 44 p refs
(Contract AT(30-1)-1480)
(NYO-1480-5)

Several simple initial-value problems based on an equation of the form $\partial/\partial t\ u + \partial/\partial x\ u^2/2 = \psi$, where $\psi$ is a given function, are considered, and the stability of certain difference schemes for these problems is studied numerically. The leapfrog scheme (with and without a dissipative term), the Lax–Wendroff equation, and a semi-implicit 4-point scheme are compared. Also the difference equations for coupled sound and heat flow, in which the latter is treated implicitly, are considered. The stability condition is known to be $c\ \Delta t/\Delta x < 1$, where c is the isothermal sound speed. Author

**N65-12984#** Los Alamos Scientific Lab., N. Mex.
**SIX-PLACE TABLES OF THE DEBYE FUNCTIONS $(E-E_o)/3RT$, $C_v/3R$, AND $S/3R$**
John E. Kilpatrick (Rice U.) and Robert H. Sherman 30 Oct. 1964 61 p refs
(Contract W-7405-ENG-36)
(LA-3114) OTS: $3.00

Six-decimal-place tables of the three Debye functions $(E-E_o)/3RT$, $C_v/3R$, and $S/3R$ have been calculated as functions of $\theta/T$ for the range 0(0.001)6(0.01)20(0.1)49.9. Author

**N65-13009#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**SOME QUESTIONS ABOUT THE NOISE STABILITY OF THE FUNCTIONS OF ALGEBRA OF LOGIC**
A. V. Petrosyan 15 Oct. 1964 10 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Arm. SSR (Erevan), v. 36, no. 3, 1963 p 147–151
(FTD-TT-64-675/1+4; AD-608046)

The question of reprocessing of information by the functions of the algebra of logic is examined from the point of view of the noise stability of the functions. It is shown (1) that any function of the algebra of logic can be connected to some continuous function characterizing the noise stability of the given function, (2) that the noise stability of all functions of the algebra of logic have one and the same order of smallness, and (3) that the noise stability of the function can be increased only by the introduction of redundancy. It is also proven that for any function of the algebra of logic another function can be constructed, which reprocesses the information of the original function, but which possesses noise stability of a higher order. P.V.E.

**N65-13018#** Systems Technology, Inc., Inglewood, Calif.
**EXTENSION OF LINEAR CONSTANT-COEFFICIENT ANALYSIS METHODS TO TIME-VARYING SYSTEMS Technical Documentary Report, Mar. 1962–Oct. 1963**
Walter A. Johnson, Duane T. Mc Ruer, and Anil V. Phatak Wright-Patterson AFB, Ohio, AF Flight Dyn. Lab., Sep. 1964 129 p refs
(Contract AF 33(657)-8294)
(RTD-TDR-63-4178; AD-608621)

For system characterization, constant-coefficient concepts are reviewed, and their time-varying parallels are introduced; kernel functions and system functions are evolved by analogy with their constant-coefficient counterparts—weighting functions and transfer functions. For quantitative response information, a constant-coefficient series technique in which a very few constant-coefficient system responses are summed to approximate the response of a time-varying system is presented. The technique is a practical procedure for the determination of approximate kernel functions or other system response characteristics. The qualitative response or stability nature of certain time-varying systems is also treated. For some systems, identification of asymptotic system characteristics with known Euler or constant-coefficient system solutions allows constant-coefficient stability criteria to be applied to a variety of time-varying-coefficient problems. Author

**N65-13038#** Wisconsin U., Madison. Mathematics Research Center
**OPTIMAL WINDOWS FOR POWER SPECTRA ESTIMATION**
Donald G. Watts Sep. 1964 40 p refs
(Contract DA-11-022-ORD-2059)
(MRC-506; AD-607822)

Two classes of optimal spectral windows are derived. These windows are compared with empirical windows used, e.g. Bartlett, Hanning, Parzen, and are found to be generally superior to them on a mean-square-error basis. Some of the considerations of bandwidth and resolution of spectral windows are discussed and clarified. Author

**N65-13047#** Litton Systems, Inc., Waltham, Mass. Information Sciences Lab.
**PATTERN RECOGNITION RESEARCH Final Report**
George Sebestyen and Jay Edie 14 Jun. 1964 134 p refs
(Contract AF 19(628)-1604)
(DS-64-025; AFCRL-64-821; AD-608692)

This report is concerned with the adaptive estimation of joint probability densities from a finite number of multidimensional vectors of known classification. An estimation procedure for the approximation of probability densities in the form of an n-dimensional histogram is described. The location and shape of the cells in the histogram are dependent on the data. The quality of the estimation procedure and its dependence on the order in which samples of known classification are introduced are described. Two quality measures are studied, one that estimates the probability that the decision is optimum

and the other that the decision is correct. Techniques for analysis of data of unknown origin prior to the application of the adaptive pattern-recognition techniques are studied. The measurement selection problem of pattern recognition is investigated, and the mathematical and engineering problems are separated. Author

**N65-13065#** System Development Corp., Santa Monica, Calif.
**ON THE CONCEPT OF FIFOV IN QUEUES**
B. Krishnamoorthi 5 Aug. 1964 24 p refs
(SP-1729(000)00; AD-606172) OTS: $1.00

In several queuing situations, the order in which the units depart is not the same as the order in which they arrived at the system. This phenomenon is called the "violation of the 'first in, first out' principle" (FIFOV). A quantitative study of FIFOV is of operational importance in tandem queuing and many other situations. In this paper a general discussion is given of the concept and a special aspect of FIFOV is studied in a Poisson queue (Poisson input and exponential service times) with two heterogeneous servers working in parallel. In this connection the time-dependent distribution of the output in a M|M|1 queue was explicitly obtained. Defining X as the number of customers superseding a customer taking service from the slower channel, the distribution and the first two moments of X are obtained under a queue discipline that is a modification of the usual one. Author

**N65-13136#** Aerojet-General Corp., Sacramento, Calif.
**DEVELOPMENT OF IMPROVED RESIN SYSTEMS FOR FILAMENT-WOUND STRUCTURES Final Report, 25 Jun. 1963–29 May 1964**
J. J. Cooney Aug. 1964 293 p
(Contract NOw-63-0627-C(FBM))
(Rept.-0627-VI-F; AD-605179) OTS: $7.00

The relationships between five resin system parameters and 18 physical properties of the resins were investigated using statistical techniques. The epoxy resin system chosen was bisphenol-A diglycidyl ether resin. The results indicate that the type and amount of hardener used are the most important of the parameters studied in effecting changes of properties, especially for those resin systems that contain amine hardeners. Relationships between the physical properties of the resins and those of a filament-wound composite were investigated through fabrication and bursting of pressure vessels and through short-span flexural tests of ring samples for interlaminar shear-strength determinations. Correlation analysis has shown the majority of 18 resin properties to be interdependent. High degrees of correlation were found between tensile modulus and dynamic shear modulus, and between heat distortion temperature and major glass-transition temperature. D.S.G.

**N65-13139*#** Tennessee U., Knoxville.
**METHOD OF ADJOINT SYSTEMS AND ITS ENGINEERING APPLICATIONS Technical Note No. 1**
J. C. Hung 10 Oct. 1964 39 p refs
(Contract NAS8-11183)
(NASA-CR-59825) OTS Prices: HC $2.00/MF $0.50

A tutorial account of the method of adjoint systems and its application to engineering problems is presented. The fundamentals for the solution of vector differential equations with time-varying coefficients are considered, and the adjoint system in both vector equation form and differential operator form are presented. Several important properties of the adjoint system are also discussed. P.V.E.

**N65-13150*#** Martin Co., Baltimore, Md. RIAS Div.
**ATTRACTORS IN DYNAMICAL SYSTEMS**
J. Auslander, N. P. Bhatia, and P. Seibert [1963] 23 p refs
(Contracts NASw-845; AF 49(638)-1242)
(NASA-CR-59858) OTS Prices: HC $1.00/MF $0.50

A study of the properties of attractors, without explicitly assuming stability, is discussed. By Liapunov stability (or plain stability) of the compact invariant set M, it is meant that every orbit starting sufficiently close to M will remain in a neighborhood of M. The set M is asymptotically stable if it is stable, and is also an "attractor"—i.e., all orbits in a neighborhood A(M) of M approach M. Some of the basic notions of dynamical systems and stability theory are discussed along with several examples of attractors. The prolongation of a point and the prolongational limit set of an orbit are used to clarify the connection between attractors and stability. The assumption that the prolongational limit set of A(M) – M is contained in M is examined, and it is concluded that the assumption (suitably localized) is, in general, valid for attractors. P.V.E.

**N65-13160**
**FORMULAS FOR OBTAINING SOLUTIONS OF DIFFERENTIAL EQUATIONS BY EVALUATIONS OF FUNCTIONS**
E. Baylis Shanks (Vanderbilt U.) [1963] 12 p

Formulas are derived and presented for the solution of differential equations by the evaluation of functions. The formulas were designed to give better results than those formulas already in the literature. The best known of these are the Runge–Kutta 4-4 formula, the Kutta–Nystrom 5-6 formula, and the Huta 6-8 formula. The author's 4-4 formula was compared on an IBM-7094 computer with the Runge–Kutta 4-4 formula, and was found to be about 9% faster and to yield about 1/3 less error. D.E.W.

**N65-13186#** Laboratoire de Physique Theorique et des Haute Energies, Orsay (France).
**A COVARIANT THEORY OF RELATIVISTIC BROWNIAN MOTION. II: APPROACH TOWARDS "LOCAL EQUILIBRIUM"**
Remi Hakim Nov. 1964 52 p refs
(TH-68)

The classical results on brownian motion are generalized from a relativistic point of view. Essentially, a covariant Langevin equation and a covariant Fokker–Planck equation (which can be reduced to an equation the form of which is similar to that given by Klimontovich) are given. As a characteristic feature of the relativistic brownian motion, the mass is no longer a constant, but rather a random function. Author

**N65-13196#** Princeton U., N.J. Digital Systems Lab.
**ON DETERMINATION OF THE IRREDUNDANT COVERS OF A PRIME IMPLICANT TABLE**
Amerendra Mukhopadhyay Jul. 1964 20 p refs
(TR-36; AD-607227) OTS: $1.00

An algorithm for generating the irredundant covers of a prime implicant table is discussed in this paper. The method depends on a representation of the prime implicant table on a "prime implicant lattice" defined in terms of a partial ordering that takes its motivation from the equation $x + xy = x$. The problem is formulated in terms of certain properties on the lattice, and a solution primarily based on geometrical interpretation is proposed. The novelty in the formulation lies in the fact that the solution is expressed as a product-of-sums expression that has factors with both uncomplemented and

complemented variables. The presence of these factors with complemented variables can be profitably utilized to yield an efficient branching procedure for reducing the redundancy.
Author

**N65-13211#** Purdue U., Lafayette, Ind.
**STUDIES ON CONSTITUTIVE EQUATIONS OF FIRST AND SECOND ORDER VISCOELASTICITY**
George Lianis and Paul H. De Hoff, Jr. Sep. 1964 44 p refs
(NSF GP-2677)
(A&ES-64-10)

By expanding a general constitutive equation in a polynomial series of linear functionals the forms of first- and second-order viscoelastic equations for isotropic and transversely isotropic media are studied. These equations are specified for small dynamic strains superposed on large static deformation. The latter form is found adequate for the application of the theory of linear irreversible thermodynamics. Onsager's principle simplifies considerably both the transient and the steady-state terms of the constitutive equations.
Author

**N65-13212#** New York U., N.Y. Courant Inst. of Mathematical Sciences
**THEORY OF THE BOLTZMANN EQUATION**
Harold Grad Aug. 1964 27 p refs Presented at the 11th Intern. Congr. of Appl. Mech., Munich, Aug. 1964
(Grant AF-AFOSR-62-266)
(MF-40; AFOSR64-1377)

Presented is a survey of recent developments in the theory of the Boltzmann equation for a dilute monatomic gas. These advances are characterized by increased sophistication in mathematical techniques, improved understanding of the significance of older approximate results, and a general trend from ad hoc toward more precise mathematical procedures. Over the range of linear problems, a continuous spectrum in the collision operator and the streaming operator indicates the inadequacy of traditional exponential "normal mode" expansions in initial and boundary-value problems. Results in all the regimes were unified by the overall qualitative understanding given by a more comprehensive existence theory that, for the first time, is broad enough to encompass the transition to macroscopic continuum flow.
Author

**N65-13223*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**PERFORMANCE CHARACTERISTICS OF HIGHER ORDER APPROXIMATIONS OF RUNGE-KUTTA TYPE**
E. Baylis Shanks 8 Mar. 1963 9 p
(NASA-TM-X-54892; MIN-COMP-63-2) OTS Prices: HC $1.00/MF $0.50

An analysis is given of performance characteristics of higher order approximations of Runge–Kutta type. Performance predictors for the time required on the machine and for the size of the error are developed. These predictors are not supposed to give precise information, but supporting data are given that indicate useful information is obtained from the predictors. The predictors and the data indicate that the usual formulas used should be Shanks' formulas of order six, seven, and eight.
Author

**N65-13244#** Carnegie Inst. of Tech., Pittsburgh, Pa.
**A COMPARATIVE ANALYSIS OF SOME ALTERNATIVES TO THE SHEWHART CONTROL-CHART TECHNIQUE Final Report, 17 Sep. 1954–31 Aug. 1964**
M. H. De Groot and M. M. Rao 1 Oct. 1964 refs
(Contract DA-36-061-ORD-447)
(AROD-1280-13; AD-608338)

A general review of formerly presented alternatives to the Shewhart Control-Chart Technique and of several problems of estimating a multidimensional parameter is presented. A detailed study of the efficiencies of estimators under certain regularity conditions on the families of distribution functions has been carried out. The equivalence of the linear independence of a vector of estimators with the invertibility of the estimated functions is shown. The dependence between a set of measurements made on one individual and a set of similar measurements made on a closely related individual is being investigated, and the problem of finding conditions for the existence and explicit construction of estimators with minimum risk at a given point among all unbiased estimators of a parametric function is considered.
G.G.

**N65-13287#** RAND Corp., Santa Monica, Calif.
**TRUNCATED SEQUENTIAL HYPOTHESIS TEST**
Julian J. Bussgang and Michael B. Marcus Nov. 1964 25 p refs
(ARPA SD-79; ARPA Order-189-61)
(RM-4268-ARPA; AD-452602)

Through examination of the equations by which Wald determines the values of the boundaries for tests of sequential hypotheses, relationships are obtained for the conditional probability distributions of the stage at which the test terminates. Sequential tests in which the boundaries are functions of the sample number are studied. In tests with convergent boundaries, a set of boundaries are investigated that approach those of a truncated Wald test. Approximate expressions for the expected sample number and probabilities of error are obtained for the tests considered. The obtained approximations apply best for gently tapering slopes. Extensions can be applied to evaluate various ad hoc schemes for truncating tests and to the theory of tests with a varying parameter.
Author

**N65-13312#** Wisconsin U., Madison.
**BAYESIAN ANALYSIS OF THE REGRESSION MODEL WITH AUTOCORRELATED ERRORS**
Arnold Zellner and George C. Tiao Dec. 1963 24 p refs
(NSF GS-151)
(TR-22; AD-604259) OTS: $2.00

Bayesian methods are used to analyze the regression model with errors generated by a first-order autoregressive scheme. Finite-sample joint, conditional, and marginal distributions of the parameters of the simple regression model are derived. With these distributions, inferences can be made about parameters, and the way in which departures from independence affect these inferences can be studied. This approach provides a unified treatment of nonexplosive and explosive models, and yields results for deciding whether a process is or is not explosive. To illustrate application of the techniques, two sets of artificially generated data, one set from a nonexplosive model and the other from an explosive model, are analyzed in detail. Subsequently, techniques are developed for a Bayesian analysis of the multiple regression model with autocorrelated errors.
D.S.G.

**N65-13322#** Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
**HARMONIC FUNCTIONS AND HITTING DISTRIBUTIONS FOR MARKOV PROCESSES Mathematical Note No. 387**

G. B. Crawford Sep. 1964 13 p refs
(DI-82-0375; AD-607351) OTS: $1.00

For a Markov process satisfying Hunt's condition A, the class of harmonic functions completely determines the family of hitting distributions. For certain processes in two dimensions these hitting distributions are completely determined by two suitably chosen, independent, harmonic functions. This result parallels and extends the well known one-dimensional result that hitting distributions are completely determined by one harmonic function. Author

**N65-13332#** Harvard U., Cambridge, Mass. Cruft Lab.
**GENERATING FUNCTIONS OF ABSTRACT GRAPHS WITH APPLICATIONS**
C. V. Ramamoorthy and D. W. Tufts 24 Mar. 1964 62 p refs
(Contract Nonr-1866(16))
(TR-439; AD-607254) OTS: $3.00

The generating function of a graph is a function of the complex variable z, which has the property that interesting attributes of the graph can be extracted from it by numerical operations. The generating function can be written as a standard rational function of z, and the denominator is called the characteristic function of the graph. This latter function can also be obtained independently. The computation of the generating function involves either matrix inversions or application of formulas that take into account the topological characteristics of the graph. When the given graph has certain orderly topological features, the topological method gives the generating function explicitly, even when the graph contains an extremely large number of nodes. However, if the graph has been chosen at random, often no advantage can be derived from a topological characterization. The matrix method can then be applied, but computational complexity restricts the size of graphs that can be analyzed. Author

# 20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

**N65-12343#** Atomic Energy of Canada Ltd., Chalk River, Ontario.
**SOME RECENT EXPERIMENTS ON TRANSFER OF RADIOACTIVE TRACERS FROM AIR TO NATURAL SURFACES**
P. J. Barry 14 May 1964 19 p
(CRL-86; AECL-2045) Available from Atomic Energy of Canada, Chalk River: $0.50

Field experiments to measure the rate of deposition of titrated water vapor and radioiodine vapor to natural snow surfaces are described. The meteorological applications of the results obtained in the field of gaseous exchange between atmosphere and the earth's surface, such as evaporation and evapo-transpiration, are discussed. By simultaneously measuring the rates of deposition of two radioactive tracers having different molecular diffusivities, it has been found that molecular diffusion, in addition to turbulent eddy diffusion, plays an important role because the presence of a laminar sublayer is in close proximity to the surface. By comparing the relative transfer rates for the two tracers, it is possible to estimate the thickness of the laminar sublayer. Author

**N65-12349#** Boeing Co., Seattle, Wash.
**A STUDY OF DISCONTINUOUS MASS TRANSFER UTILIZING THE BOUNDARY LAYER INTEGRAL EQUATIONS**
L. W. Woodruff [1964] 62 p refs
(DZ-23556; AD-448959)

The skin friction and heat transfer downstream of a discontinuity in mass transfer are investigated analytically. A method for determining the surface conditions downstream of either a transpiring strip or an impermeable strip in a transpiring flat plate is proposed. The method involves solving the integral equations for the laminar or turbulent boundary layer by approximating the growth of the integral downstream of the discontinuity with a simple quadratic in terms of the reciprocal of the distance. The surface is assumed to be isothermal, but the effects of foreign gas injection are included. Three working relations are derived that give the downstream skin friction or heat transfer in terms of a flow parameter, dependent on whether the flow is laminar or turbulent, a blowing parameter, and the reduction in skin friction or heat transfer for the case of continuous, similarity injection from the leading edge. Results from the present analysis are in good agreement with more exact solutions for the influence of upstream air injection on the downstream laminar skin friction. Author

**N65-12439*#** Texas A&M Research Foundation, College Station.
**AN INVESTIGATION TO ESTABLISH LOW-LEVEL TURBULENT WIND DEFINITION IN TERMS OF MEAN MICROMETEOROLOGICAL PARAMETERS Summary Report, 30 Apr. 1962–30 Sep. 1963**
31 Oct. 1963 103 p refs
(Contract NAS8-2652)
(NASA-CR-59719) OTS Prices: HC $4.00/MF $0.75

Activities are summarized on the selection and installation of measurement capabilities for a research program designed to afford definition of the instantaneous or gust-wind profile as a function of mean flow definition. Included are a review of sonic anemometer theory pertinent to the research goals of the study, a schematic description of the sonic anemometry employed, and outlines of analytical procedures and techniques to be followed, as well as the details of a comparative field-measurement test covering various types of wind-measurement instrumentation in current use. Author

**N65-12455#** Aerometric Research, Inc., Goleta, Calif.
**SILENT AREA ANALYSIS USING TIROS DATA Final Report**
John R. Thompson, John C. Cronin, and Raymond E. Kerr, Jr.
Sep. 1964 143 p refs
(Contract N-189(188)-57542A)
(AD-448466)

The TIROS cloud photographs from TIROS IV, V, and VI, for the period from February through December 1962, were selected for evidence of frontal bands or vortexes and used for a synoptic analysis in silent areas. Evaluation rules pertaining to vortexes, cloud bands, cloud masses, lines, and for establishing a useful relationship, in order to sharpen the analysis were formed and are presented. Infrared data in the current form were found to lack the resolution to delineate any but the major cloud formations. G.G.

**N65-12512#** Naval Postgraduate School, Monterey, Calif.
**HIGHER ORDER FINITE-DIFFERENCE APPROXIMATIONS IN NUMERICAL WEATHER PREDICTION**

Donald Chin (M.S. Thesis) 1964 39 p refs
(AD-603430)

One method of reducing truncation error in numerical prediction is the use of more accurate finite-difference approximations. A relatively simple barotropic model is employed as a basic program in testing several higher order finite-differencing schemes. Forecasts were computed to 24 and 48 hours with modifications of the basic model, and comparisons were made with the analyses at verifying time. This study determines the effects of some higher order finite-difference approximations in this numerical prediction model. Author

**N65-12541#** Joint Publications Research Service, Washington, D.C.

**THE PROBLEM OF RECORDING THE LIQUID WATER CONTENT OF CLOUDS**

V. A. Zaytsev and A. A. Ledokhovich 15 Dec. 1964 10 p refs Transl. into ENGLISH from Tr. Arkticheskogo i Antarkt. Nauchno-issled. Inst. (Leningrad), v. 239, no. 2, 1962 p 128–133
(JPRS-27845; TT-64-51939) OTS: $1.00

A remote-control, electrical, airborne, liquid-water gage is described that functions in connection with an automatic optical recorder as a continuous observer of the liquid-water content in clouds. This instrument contains two heated cone-shaped sensors; one is placed in the flow nozzle, and the other is fastened in the breaking nozzle. Both sensors are ventilated identically during the time of flight, and the quantity of the evaporating water on a working element of the instrument is determined by elementary computation. G.G.

**N65-12542#** Joint Publications Research Service, Washington, D.C.

**NUMERICAL FORECAST OF WEATHER ON A SPHERICAL SYSTEM OF COORDINATES**

G. I. Marchuk 17 Dec. 1964 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 156, no. 4, 1964 p 810–813
(JPRS-27899; TT-64-51964) OTS: $1.00

This study pertains to the problem of predicting the weather on a spherical earth in a three-dimensional baroclinic atmosphere. The simplifications that are natural for the atmospheric processes are taken into account to form a model convenient for calculations; a numerical method employing a specific set of elementary algorithms is used to solve the resulting system of equations. The accounting for turbulent exchanges and detailed considerations of the influx of heat do not introduce fundamental changes in the calculation scheme. G.G.

**N65-12663#** Joint Publications Research Service, Washington, D.C.

**METEOROLOGICAL CONDITIONS FOR AIRCRAFT ICING IN As AND Ac CLOUDS**

L. P. Burova and A. I. Voskresenskiy 15 Dec. 1964 17 p refs Transl. into ENGLISH from Tr. Arkticheskogo i Antarkt. Nauchno.-Issled. Inst. (Leningrad), v. 239, no. 2, 1962 p 95–103
(JPRS-27844; TT-64-51938) OTS: $1.00

This study presents the meteorological conditions leading to the icing of propeller-driven aircraft in middle-level Arctic clouds. Middle-level frontal clouds whose vertical thickness can attain 1,000 m or more are most apt to produce icing of the propellers. However, since these clouds contain "dry" layers of a vertical thickness as great as 100 m and a horizontal extent of approximately 100 km, a certain number of ice-free flights are possible. G.G.

**N65-12665#** Joint Publications Research Service, Washington, D.C.

**MEASUREMENT OF ATMOSPHERIC PRESSURE USING AN ELECTRICAL HYPSOTHERMOMETER**

V. A. Zaytsev and A. A. Ledokhovich 15 Dec. 1964 8 p refs Transl. into ENGLISH from Tr. Arkticheskogo i Antarkt. Nauchno.-Issled. Inst. (Leningrad), v. 239, no. 2, 1962 p 139–143
(JPRS-27847; TT-64-51941) OTS: $1.00

An electric hypsothermometer was designed for continuous measurement of the boiling point of distilled water under the varying atmospheric pressures encountered at high altitudes. The use of a readily available automatic recorder enables the continuous measurement of the altitude with a much greater accuracy than is possible with aneroid barometers and altimeters. D.E.W.

**N65-12760#** Joint Publications Research Service, Washington, D.C.

**CONDENSATION NUCLEI AND THE CONCENTRATION OF CLOUD DROPLETS IN ARCTIC CLOUDS**

A. I. Voskresenskiy 15 Dec. 1964 19 p refs Transl. into ENGLISH from Tr. Arkticheskogo i Antarkt. Nauchno-Issled. Inst. (Leningrad), v. 239, no. 2, 1962 p 64–74
(JPRS-27843; TT-64-51937) OTS: $1.00

Experiments from 1932 to 1960 are described in which condensation nuclei were measured in the Arctic atmosphere. Conclusions drawn from the data considered include the following: The concentration of atmospheric nuclei in the Arctic is less than in the temperate latitudes, averaging about 300 nuclei/$cm^3$ and having a maximum less than 1500/$cm^3$. On the average in the latitudinal distribution of nuclei there is a decrease in the quantity of nuclei in the high latitudes. The temperature stratification of the Arctic atmosphere, as in the temperate latitudes, plays an important role in the distribution of nuclei with height. D.E.W.

**N65-12761#** Joint Publications Research Service, Washington, D.C.

**CLOUD INVESTIGATIONS IN THE ARCTIC**

I. M. Dolgin 15 Dec. 1964 12 p refs Transl. into ENGLISH from Tr. Arkticheskogo i Antarkt. Nauchno-Issled. Inst. (Leningrad), v. 239, no. 2, 1962 p 5–10
(JPRS-27842; TT-64-51936) OTS: $1.00

The Russian program of observation of clouds and fog in Arctic regions is reviewed. Observations of extent of clouds, type of atmospheric circulation, water content of clouds, drop size distribution, and turbulent exchange coefficient are discussed. Needs for further observations and for different types of data are expressed. D.E.W.

**N65-12809*#** General Mills, Inc., Minneapolis, Minn.

**EVALUATION OF METEOROLOGICAL ROCKET DATA**

A. Belmont, R. Peterson, and W. Shen Washington, NASA, Dec. 1964 104 p refs
(Contract NASw-558)
(NASA-CR-138) OTS Prices: HC $2.50/MF $0.75

The published properties and accuracy of meteorological rocket and rawin systems are summarized. Rocket and rawin wind observations for about three years are compared. Eighty percent of the differences between them are within 5 msec, although the extremes may reach 25 msec. The atmospheric layer represented by each reported M/R wind varies from about 800 meters at 20 km to 2700 meters near 55 km, compared with about 1300 to 1600 meters for rawin winds below 30 km.

There are no rocket data yet available to show the vertical progression of the fall reversal process at high altitudes. Both rocket and rawin data agree on downward progression in spring. Recommendations are offered to enable more significant use of rocket data. Author

**N65-12871#** Joint Publications Research Service, Washington, D.C.
**RESEARCH ACTIVITIES OF THE INSTITUTE OF METEOROLOGY IN RUMANIA**
Dumitru Tistea and Dumitru Bacinschi 3 Dec. 1964 11 p Transl. into ENGLISH from Hidrotehnica (Bucharest), v. 9, no. 8, Aug. 1964 p 439–445
(JPRS-27666; TT-64-51856)

A brief discussion is presented of the history and development of the Institute of Meteorology since its founding. P.V.E.

**N65-12876#** Weapons Research Establishment (Australia).
**A YEAR'S SURVEY OF ATMOSPHERIC "SEEING" CONDITIONS AT WOOMERA**
C. B. Rogers Jul. 1964 21 p refs
(WRE-TN-ISD-40)

A camera fitted with a long focal length lens was used to photograph a resolution chart, distance 8000 ft, along a horizontal sight line. The apparatus was automatic and ran continuously for the period July 1962–August 1963. The results were analyzed to give statistical information on the diurnal and seasonal variations in atmospheric "seeing" and detectability. Author

**N65-12877#** Weapons Research Establishment (Australia).
**THE VARIATION OF ATMOSPHERIC "SEEING" BLUR WITH OBJECT-TO-OBSERVER DISTANCE**
C. B. Rogers Jul. 1964 12 p refs
(WRE-TN-ISD-51)

A study has been made of the image blurring introduced by a thermally turbulent atmosphere under different "seeing" conditions for horizontal lines of sight. The radius of the blur circle is shown to increase approximately as the square root of the range up to the maximum range available (3000 yards). This is in good agreement with a recent theoretical model of light transmission through an optically nonuniform medium. Author

**N65-12878#** Weapons Research Establishment (Australia).
**TWO FALLING SPHERE RESULTS FOR WOOMERA EXTENDED TO INCLUDE THE SUBSONIC REGION**
P. H. O. Pearson Jul. 1964 26 p refs
(WRE-TN-PAD-87)

Two falling sphere experiments were conducted in December 1963 and March 1964 to obtain atmospheric density, temperature, and pressure. These basic parameters were successfully obtained from 320 000 to 140 000 ft, and the results are presented together with an extension of the error assessment to the subsonic region below 230 000 ft. Author

**N65-12914#** Technische Hochschule Darmstadt (W. Germany). Inst. für Meteorologie
**RESEARCH IN ATMOSPHERIC MACROTURBULENCE Final Report**
F. W. Wippermann et al 30 Jun. 1964 186 p refs
(Contract AF 61(052)-366)
(AFCRL-64-867; AD-608442)

A study of the application of results of atmospheric macroturbulence investigations to microturbulence and vice versa is reported. An interrelation between the Eulerian and Lagrangian correlation function is established and checked for the case of macroturbulence. The time dependence of the standard deviation of expanding clusters is evaluated, and a characteristic time scale of large-scale turbulence is defined and computed. Then the standard deviation of large-scale horizontal expansion of clusters is correlated with the deformation of the wind velocity field. A method for two-dimensional spectral analysis of kinetic energy over a circumpolar area of a sphere is presented and applied. Several diffusion equations applicable to large-scale diffusion processes are studied; by introducing a relaxation time, the equation valid for very small scale diffusion can be applied to very large scale diffusion processes. These results are correlated with the correct specification of boundary conditions in problems of numerical weather prediction. M.P.G.

**N65-13005#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**PRACTICAL METHODS OF NUMERICAL WEATHER PREDICTION**
P. N. Belov 25 Sep. 1964 272 p refs Transl. into ENGLISH of the book "Prakticheskiye Metody Chislennogo Prognoza Pogody" Leningrad, Gidrometeorologicheskoye Izd., 1963 p 1–255
(FTD-MT-64-119; AD-608162)

Several methods for numerical weather prediction are developed and presented under the following headings: "Fundamental Equations of Hydrodynamics and Thermodynamics and Their Analysis"; "Forecast at the Mean Level"; "The Prediction of Pressure and Vertical Motions at Several Levels"; "Numerical Analysis of Meteorological Information"; "Statistical Forecast Methods"; and "Programing for Electric Computers." Also presented in annexes are "Certain Laws of Higher Mathematics" and "Standard Atmosphere" G.G.

**N65-13170#** Naval Postgraduate School, Monterey, Calif.
**SOME NUMERICAL EXPERIMENTS WITH THE PRIMITIVE EQUATIONS OF MOTION**
Charles L. Bennett and Leslie L. Britten (M.S. Thesis) 1964 43 p refs
(AD-603434) OTS: $2.00

A simple primitive-equation model for numerical prediction of wind fields and temperature fields at 800 and 400 mb is developed and programed. Numerical experiments are conducted with this model in an effort to suppress the spurious instability encountered in solution of the primitive equations. The model proves to be very sensitive to spatial finite-differencing schemes. The schemes developed in this study tend to suppress the instability resulting from truncation and round-off error. Instability resulting from unrealistic boundary conditions for a limited forecast region is reduced by not allowing advection across the boundaries and appears to be controlled by the finite-differencing schemes used in this study. Author

**N65-13231#** Miami U., Coral Gables, Fla. Inst. of Marine Science
**MESOSCALE STUDIES OF INSTABILITY PATTERNS AND WINDS IN THE TROPICS Second Semiannual Report, 1 Dec. 1963–31 May 1964**
Harold P. Gerrish and Homer W. Hiser Jul. 1964 66 p refs
(Contract DA-36-039-SC-89111)
(Rept.-5; AD-451007)

Heights of radio–radar rays at various antenna elevation angles are theoretically determined for the moist season at Miami, Florida. These values, which are also valid for general summer conditions in the tropics, are used as a basis for outlining proposed procedures to manually collect CAPPI data and to photointegrate radar PPI-scope presentations. A three-dimensional analysis of a precipitation-free, sea-breeze front suggests that the radar "thin band" associated with the front was probably a ground target detected as a result of superrefraction. Work completed on an hourly rainfall study of South Florida for the period 1942–1962 is presented. Various hourly averages as determined by an IBM-1620 computer are illustrated for seven stations at varying distances from the southeast coast of Florida. Author

**N65-13289#** Army Cold Regions Research and Engineering Lab., Hanover, N.H.

**COLD REGIONS SCIENCE AND ENGINEERING. PART II: PHYSICAL SCIENCE. SECTION A: GEOPHYSICS. HEAT EXCHANGE AT THE GROUND SURFACE**

R. F. Scott and F. J. Sanger, ed. Jul. 1964 69 p refs
(CRREL-II-A1; AD-449434)

A summary of the types of construction suitable for those regions of the earth where frost is an engineering consideration is presented, and the particular meteorological elements upon which structural behavior depends are considered. Discussed are the reactions of the ground to the presence of the structure, the variations of the temperature field in the soil, the heat transfer in soils, the meteorological considerations for structures above the ground, the orientation of airfield runways, the heating system for an arctic building, and the necessary instrumentation to obtain meteorological data and their analysis. G.G.

**N65-13318#** Florida State U., Tallahassee.

**PRELIMINARY EXPERIMENTS IN CUMULUS MODELING WITH AN ANALOG TO THE RELEASE OF LATENT HEAT OF CONDENSATION**

Seymour L. Hess 30 Sep. 1964 26 p refs
(Contract Nonr-1600(00))
(TR-17; AD-607159)

Experiments were performed in modeling cumuli in which the upward buoyancy is produced by a chemical reaction between acid and base solutions. The method of production of buoyancy is analogous to the release of latent heat of condensation in real cumuli. The experimental convection is found to have a Reynolds number about the same as in small cumuli but a Froude number about one order of magnitude larger than in real cumuli. Author

# 21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

**N65-12474*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

**A DYNAMIC PROGRAMMING ANALYSIS OF MULTIPLE GUIDANCE CORRECTIONS OF A TRAJECTORY (REVISION NO. 1)**

Carl G. Pfeiffer 10 Aug. 1964 21 p refs
(Contract NAS7-100)
(NASA-CR-59312; JPL-TR-32-513) OTS Prices: HC $1.00/MF $0.50

The problem of deciding when to apply guidance corrections to the perturbed trajectory of a spacecraft is treated from the dynamic programing point of view. It is assumed that the objective of the guidance-correction policy is to minimize the expected value of the squared error at the final time, subject to the constraint that the total-correction capability that is expended is less than some specified value. It is shown that a correction should be performed when a certain switching function passes through zero. Assuming that the orbit-determination procedure has been prespecified, and that the statistics of the correction errors are known, the switching function is found to depend upon the instantaneous state-of-the-system, which is composed of the following: (1) the estimate of the trajectory perturbation to be corrected; (2) the variance of the error in this estimate; and (3) the correction capability of the spacecraft. Equations for computing the switching function are derived, and a numerical example is presented. Author

**N65-12511#** France. Ministere des Armees, Paris. Centre d'Essais en Vol

**TEST OF THE FLARESCAN FLAREOUT SYSTEM IN CARAVELLE NUMBER 02**

Apr. 1964 76 p refs Transl. into ENGLISH from FRENCH

A landing-guidance system is presented that permits the guidance of an aircraft from an elevation of approximately 60 feet to the finished touchdown. It contains a microwave scanning beam of 0.5 degree in elevation and 20 degrees in azimuth. The beam carries coded pulses as a function of the instantaneous elevation-angle value to the aircraft antenna where they are received, decoded, and transformed into the corresponding elevation angle. G.G.

**N65-12644#** Federal Aviation Agency, Washington, D.C.

**A SYSTEM DESIGN FOR THE PROVISION OF A SAFER, MORE ECONOMIC, AND MORE EFFICIENT AIR TRAFFIC SERVICE FOR THE ICAO NORTH ATLANTIC REGION**

Aug. 1964 95 p refs FAA Staff Study prepared by SPANAT, "Systems Planning Approach North Atlantic Team"

A system design is presented that will meet long-term technical, operational, and economic requirements for the provision of air traffic control and related services between Europe and North America through the 1970's. All significant facts and elements related to the aircraft and the supporting facilities and services comprise an integrated, coherent scheme and are discussed as follows: (1) operational requirements; (2) the system, its concept, nature, pattern, and essential governing procedure, and (3) the equipment required. G.G.

**N65-12719** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AN ANALOG COMPUTER STUDY OF THE EFFECTIVENESS OF INTERCEPTOR COMMANDS DERIVED FROM A PREDICTION EQUATION OF SECOND ORDER**

Brian F. Doolin and John D. McLean Washington, NASA, Nov. 1958 45 p refs
(NASA-MEMO-10-7-58A) OTS Prices: HC $2.00/MF $0.50
(Declassified)

This report contains an attempt to improve the accuracy of an automatic interceptor, flying a lead-collision course against a maneuvering target. For this improvement, the prediction equations that provide the interceptor's guidance were

modified by incorporating terms of second order to predict the future location of a steadily maneuvering target. The interceptor commands derived from the second-order prediction equations allow the interceptor to fly a straight line course against a target flying with constant acceleration. The stability of the system is studied by means of an analog computer. The system accuracy was evaluated in terms of rocket miss, and is compared on this basis with the performance of an interceptor with commands derived from a first-order prediction scheme. The comparison covers cases of unlimited and limited interceptor acceleration capability, constant and pulse acceleration target maneuvers, and variations in rocket speed. Author

**N65-12766#** Naval Air Development Center, Johnsville, Pa. Aeronautical Instruments Lab.
**EVALUATION OF INERTIAL SENSORS AND SYSTEMS FOR AIRCRAFT APPLICATIONS**
Ronald S. Vaughn 28 Aug. 1964 23 p refs Presented at the 2nd Inertial Guidance Test Symp.; sponsored by AF Missile Develop. Center, Holloman AFB, N. Mex.
(NADC-AI-6460; AD-449657)

Component evaluations performed at the Naval Air Development Center are directed primarily toward aircraft applications, although much of the information obtained is directly applicable to missile problems. Tests performed are described in detail, including warm up time, static drift test with power spectral density analysis, and change in bias. A more detailed analysis of tumbling data is performed. Wheel performance parameters are monitored as indicators of gyro life. Accelerometer tests are also described, including the extensive use of 72-point and 6-point tumbling tests, temperature cycling, magnetic sensitivity tests, and warm up test. Author

**N65-12781#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering
**MULTISATELLITE CONTROL**
Aloysius Gerald Casey (M.S. Thesis) Aug. 1964 105 p refs
(GA-EE-64-1; AD-607033) OTS: $4.00

A method of controlling a system of orbiting satellites through a net of servicing ground stations is described. The problem is defined, and a solution based on a dual view of the time spectrum is selected. That is, the vital service requirements are scheduled horizontally across the scheduling period, while the routine reports are treated vertically in time. The report includes a computer program that is written in the FORTRAN IV language and based on the logical development explained in this paper. A 10-satellite–5-ground-station problem is presented. Author

**N65-13278*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**RANGER BLOCK III ATTITUDE CONTROL SYSTEM**
Will Turk 15 Nov. 1964 179 p refs
(Contract NAS7-100)
(NASA-CR-59903; JPL-TR-32-663) OTS Prices: HC $5.00/MF $1.00

This report describes the attitude-control system designed to orientate, stabilize, and maneuver the Ranger spacecraft in its mission to obtain the first detailed close-up television pictures of the moon's surface. The system is capable of three-axis orientation, midcourse trajectory correction, and terminal orientation for picture taking. The attitude-control system is composed of several subsystems: the inertial sensors to sense the rates and positions about each axis and to serve in a trajectory correction and orientation during terminal; the celestial sensors to provide for the sun and earth reference coordinates for the three-axis position stabilization; and, the gas jet system to provide the torque control for the spacecraft. Each of the modes of spacecraft attitude-control operation is discussed in detail. A complete analysis of the gas-system requirements, spacecraft dynamic effects, and midcourse autopilot control, as well as the maneuver error analyses, is included. Also included is a discussion of the subsystem concept, design, and development. Author

# 22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

**N65-12435#** Massachusetts Inst. of Tech., Cambridge.
**ANALYTICAL AND EXPERIMENTAL INVESTIGATIONS OF THE BEHAVIOR OF THERMAL NEUTRONS IN LATTICES OF URANIUM METAL RODS IN HEAVY WATER**
R. Simms, I. Kaplan, T. J. Thompson, and D. D. Lanning Washington, AEC, 11 Oct. 1963 220 p refs
(Contract AT(30-1)-2344)
(MITNE-33; NYO-10211) OTS: $6.00

Measurements of the intracellular distribution of the activation of foils by neutrons were made in lattices of 1/4-in.-diam, 1.03% U-235, uranium rods moderated by heavy water, with bare and cadmium-covered foils of gold, depleted uranium, lutetium, europium, and copper. Two lattices were studied in detail. The more closely packed lattice had a triangular spacing of 1.25 inches, and the less closely packed lattice had a triangular spacing of 2.5 inches. An analytical treatment of the problem of the flux perturbation in a foil was developed and compared to the experimental results obtained by using gold foils of four different thicknesses in the lattice cell. An analytical method to treat the effect of leakage from an exponential assembly was formulated. A method was developed to predict the cadmium ratio of the foils used in the lattice cell; comparison with available measurements with gold foils indicated generally good agreement between theory and experiment. Author

**N65-12457#** Atomic Energy of Canada Ltd., Chalk River, Ontario.
**THE STOKE PROGRAMS FOR REACTOR FUELLING**
W. M. Barss and P. M. Attree Jun. 1964 108 p
(AECL-2058; CRRP-1199) Available from Atomic Energy of Canada, Chalk River: $3.00

The STOKE computer programs simulate the performance of reactors that can be represented by a two-dimensional model, in R-Z geometry. The simulation represents the changing spatial distributions of neutron flux and fuel irradiation, taking into account both the passage of time and the mechanical shifting of fuel within the reactor. The programs are designed to test various fuel management rules by which the computer, like a reactor operator, can first recognize when a fuel shift is required and then execute a shift that is selected from an analysis of the current state of the reactor, rather than

from a fueling schedule prescribed in advance. In this way, reactor performance can be determined as a function of the fueling rules, with minimum dependence on the approximations involved in the calculations. For the CANDU reactor, STOKE has been used to develop two sets of fueling rules. Either set, with an appropriate initial fuel charge, is expected to avoid any serious loss of power output due to distortion of the flux or power distributions in the reactor. Although the fuel management rules embodied in the current version of STOKE are intended primarily for the CANDU reactor, the program is written so as to be modified conveniently for studying other reactors. Author

**N65-12466#** Stanford Research Inst., Menlo Park, Calif.
**CONTAINMENT OF FRAGMENTS FROM A RUNAWAY REACTOR Final Report**
R. W. Gates 15 Feb. 1964 140 p
(Contract AT(04-3)-115)
(SRIA-117) OTS: $2.50

A runaway reactor scale model was designed that incorporated a pressure vessel, a concrete biological shield, and an access plug. The damage sustained by the model during simulated excursions was characterized by the velocity, the number, the weight, the distribution of the fragments, and also by the distortions of the pressure vessel. The pressure pulse within the model was measured by an F-K gage. All the information of these measurements was used in an analytical program to determine the behavior of the concrete and the vessel walls; and a good agreement between the analysis and the experimental results was obtained. G.G.

**N65-12531#** Atomic Energy Commission, Berkeley, Calif. San Francisco Operations Office
**PROCEEDINGS OF THE NINTH NUCLEAR SUPERHEAT MEETING, APRIL 21, 22, AND 23, 1964, SAN JOSE, CALIFORNIA**
De Witt A. Moss, ed. 30 Jun. 1964 224 p refs
(SAN-8003) OTS: $6.00

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38. BORAX V J. I. Hagen and R. W. Goin (Argonne Natl. Lab.) p 166–177 refs

39. MSSR CRITICAL ASSEMBLY G. T. Petersen (Gen. Elec. Co.) p 178–180

40. MSCA DOPPLER MEASUREMENT R. G. Pflasterer (Gen. Elec. Co.) p 181–184 refs

41. ANALYTICAL EVALUATION OF FLOODING EFFECTS IN THE MSSR CRITICAL ASSEMBLY R. K. Haling (Gen. Elec. Co.) p 185

42. EVESR CRITICAL TEST PROGRAM SUMMARY T. Tillinghast and M. L. Weiss (Gen. Elec. Co.) p 186–189

SESSION VI: STEAM-WATER SEPARATION

43. STEAM-WATER SEPARATION J. Wilson (Allis-Chalmers Mfg. Co.) p 190–199

**N65-12635#** Iowa State U. of Science and Tech., Ames. Ames Lab.

**COMPATIBILITY STUDIES OF SEVERAL MOLTEN URANIUM AND THORIUM ALLOYS IN NIOBIUM, TANTALUM, AND YTTRIUM**

Robert James Cash, Ray M. Fisher, and Merl R. Core Feb. 1964 151 p refs

(Contract W-7405-ENG-82)

(IS-888) OTS: $2.75

Niobium, tantalum, yttrium, and Inconel have been used to contain molten aluminum, lead, tin, zinc, and several of their respective uranium and thorium alloys for various times up to 3000 hours and at temperatures ranging from 600° to 1100° C. Altogether 76 capsule tests were run, almost all in a static isothermal condition. Tantalum showed the best resistance followed by niobium, Inconel, and yttrium, respectively. The systems, lead in tantalum and lead in niobium, showed the greatest potentials for possible liquid-metal fuel-carrier systems. A background of the advantages and disadvantages of fluid-fuel reactors are compared with those for solid-fuel reactors. Differences between aqueous fuels and liquid-metal fuels are also discussed. The various types of corrosive attack of solid metals by liquid metals are defined and illustrated with several photomicrographs. Author

**N65-12646#** Hanford Atomic Products Operation, Richland, Wash. Reactor and Fuels Lab.

**COMPARISON OF BOILING BURNOUT DATA FOR 19-ROD BUNDLES IN HORIZONTAL AND VERTICAL POSITIONS**

G. M. Hesson, D. E. Fitzsimmons, and J. M. Batch Jul. 1964 15 p refs

(Contract AT(45-1)-1350)

(HW-83443, Rev. 1)

A total of 15 boiling burnout points was determined with an electrically heated model of a 19-rod bundle fuel element in a vertical position. The test section had a heated length of 76 in. and a spacing of 0.050 in. between rods maintained with a wire wrapped on a 9 in. pitch around 12 of the rods. The experimental data were obtained at coolant flow rates from 500 000 to 3 000 000 lb/(hr)(ft$^2$) and at outlet qualities from 10% to 50%. Results of these experiments were compared with data obtained previously with the same test section in a horizontal position. The data show little or no difference in the boiling burnout heat fluxes for vertical and horizontal positions when the mass flow rate is 1 000 000 lb/(hr)(ft$^2$), or greater. At a mass flow rate of 500 000 lb/(hr)(ft$^2$), however, the boiling burnout heat flux for a given outlet enthalpy was as much as 50% higher in the vertical position. Author

**N65-12647#** General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.

**RESEARCH AND DEVELOPMENT PROGRAM OF THERMIONIC CONVERSION OF HEAT TO ELECTRICITY, VOLUME I Final Technical Summary Report, 31 Oct. 1963–30 Jun. 1964**

R. H. Bristow, L. N. Grossman, and A. J. Kaznoff 30 Jun. 1964 175 p refs

(Contract NObs-88578; ARPA Order 219)

(GEST-2035; AD-605389) OTS: $5.00

The electrical conductivity of Lucalox alumina was measured under conditions representing the operational environment of a thermionic diode. Tungsten- and molybdenum-based coatings were developed, metallized to alumina, and tested in cesium vapor for over 2000 hours. Multilayered cermets were prepared but failed to prove electrically insulating. Alumina-to-nickel and alumina-to-niobium shim seals were prepared and tested for extended periods of time. The joining of various refractory metals to metallized alumina using diffusion bonding, brazing, and braze–diffusion bonding techniques was investigated. The cesium corrosion resistance of various materials and seals was determined at 1000° C. Author

**N65-12654#** General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation

**CIRCULATING BALL REACTIVITY CONTROL Final Report**

7 Dec. 1964 23 p

(Contract AT(40-1)-2847)

(GEMP-299) OTS: $2.00

This report contains the development effort expended on methods of operating a reactor control rod when sharp bends exist between the poison rod and the drive head. The use of poison balls or short spherical-ended segments as control elements and the methods of moving elements of these types are discussed. Author

**N65-12677#** Du Pont de Nemours (E.I.) and Co., Aiken, S.C. Savannah River Lab.

**DESTRUCTIVE EVALUATION OF IRRADIATED ZIRCALOY SHEATHING**

Mc Intyre R. Louthan, Jr. May 1964 17 p refs

(Contract AT(07-2)-1)

(DP-888) OTS: $0.50

The effect of irradiation on the ability of Zircaloy-sheathed oxide fuel tubes to withstand sheath strains during reactor service was determined by mechanical burst, weld-shear, and bend tests. The ductility of the sheath was not affected by irradiation exposures up to approximately $10^{20}$ fast nvt, and increases in the weld-shear strength were observed. Author

**N65-12772#** Hanford Atomic Products Operation, Richland, Wash. Hanford Labs.

**POSTIRRADIATION EVALUATION OF ZIRCALOY-2 PRTR PRESSURE TUBES—PART II**

M. C. Fraser Jul. 1964 37 p refs
(Contract AT(45-1)-1350)
(HW-83164) OTS: $2.00

Zircaloy-2 pressure tubes from a heavy-water cooled and moderated reactor were evaluated by destructive burst testing. The influence of the exposure of the tubes to fast neutrons, the tube microstructure, and the test temperature on the bursting strength and circumferential elongation was investigated. It was found that the bursting strength is more influenced by the exposure to fast neutrons than by flaws of up to 0.254 mm in depth. The bursting strength for unirradiated annealed specimens is about three to six times greater than the design stress, depending upon the bursting temperature. Flaw effective stress concentration values were obtained and compared to theoretical data. Since the tubes had a low notch sensitivity, the need for future notch sensitivity and crack propagation tests is pointed out. G.G.

**N65-12813*#** Pratt and Whitney Aircraft, East Hartford, Conn.
**DESIGN STUDY OF A HIGH POWER IN-PILE NUCLEAR THERMIONIC SPACE POWERPLANT Final Report**
A. U. Buatti and J. W. Schmitt 30 Jul. 1964 228 p
(Contract NASw-763)
(NASA-CR-54172; PWA-2351, Vol. 1)

Preliminary design studies of an in-pile nuclear thermionic system led to the selection of a powerplant that contains a thermionic reactor, a nuclear shield, a primary coolant loop, a multiple-loop heat-rejection system, and a power conditioning system. The reactor is fueled with UC-ZrC and clad with a tungsten–rhenium alloy. This powerplant is integrated into a flight configuration with a lightweight titanium support structure. It can deliver 3.25 MWe to a space vehicle assigned to complete a Jupiter-capture mission. A typical powerplant power–time profile is presented. G.G.

**N65-12826#** Union Carbide Nuclear Co., Oak Ridge, Tenn.
**ANALYSIS OF THE USE OF SOLUBLE NEUTRON ABSORBERS IN DIFFUSION PLANT EQUIPMENT**
J. C. Bailey, A. J. Mallett, C. E. Newlon, O. W. Hermann, and W. T. Mee 16 Dec. 1964 54 p refs
(Contract W-7405-ENG-26)
(K-1624) OTS: $3.00

This study was undertaken to consider the nuclear safety aspects of catastrophic fires or nonnuclear explosions in cascade equipment, including the possible use of a soluble neutron absorber in plant-fire water systems. The study indicates that a neutron absorber concentration of 14 grams boron per liter in plant sprinkler systems, added in the form of a boric acid–borax mixture, would essentially preclude a criticality incident during such contingencies. Results of the detailed nuclear safety analysis, which includes both homogeneous and two-region criticality models, are given in conventional mass units. The DTK multigroup transport code was used for all criticality calculations in this study. Author

**N65-12829#** California U., Berkeley. Lawrence Radiation Lab.
**INSTRUMENTATION AND CONTROL FOR SUPER KUKLA PROMP BURST REACTOR**
E. F. Laine 27 Jul. 1964 20 p
(Contract W-7405-ENG-48)
(UCRL-7991) OTS: $1.00

Instrumentation and control are described for the Super Kukla prompt burst reactor. The test facility, reactor control system, nuclear instrumentation, and instrumentation for the samples undergoing irradiation are described and illustrated. Author

**N65-12833#** Sandia Corp., Albuquerque, N. Mex. Sandia Lab.
**CRATERS FROM TWO CHARGES BURIED IN VERTICAL ARRAY**
Luke J. Vortman Nov. 1964 130 p refs
(SC-RR-64-1239) OTS: $4.00

A series of experiments were performed to study the crater dimensions produced by two 64-pound HE charges fired in a vertical configuration at varying depths and with varying distances between the charges. Firings were made both simultaneously and with time delays. For simultaneous firings, the dimensions are usually between those of a single charge equivalent in weight to the two charges and those of a single charge equivalent in weight to one of the charges. For long-time-delay firings (5.5 sec, with the top charge fired first), crater depths are greater than for a single charge equivalent in weight to the two charges for one spacing, whereas other dimensions fall in the range mentioned above. This increased depth is potentially the most valuable characteristic of the dual-charge technique. Short-time-delay firings (1 to 10 msec) produced depths about the same as, and radii and volumes smaller than, either simultaneous or long-delay shots. Author

**N65-12892#** Atomics International, Canoga Park, Calif.
**1000-Mwe SGR CORE OPTIMIZATION STUDIES**
H. Rood 15 Oct. 1964 53 p ref
(Contract AT(11-1)-GEN-8)
(NAA-SR-9501) OTS: $1.25

Core optimization studies were made to investigate the technical and economic characteristics of a 1000-Mwe SGR. The design of this plant is a logical extension of the SGR technology developed to date, as demonstrated by the SRE and the Hallam Reactor. The fuel element is based on present technology or a near-term extension of it. The fuel material is hypostoichiometric UC, clad in sealed stainless-steel tubes, sodium bonded. The average discharge exposure assumed attainable with this fuel, at a maximum center temperature of 2000° F, is 25 000 Mwd/MTU. The four parameters taken as independent variables for the optimization study are as follows: (1) the fuel rod diameter; (2) the number of fuel rods per element; (3) the fuel element lattice spacing; and (4) the maximum fuel temperature. The optimization study was limited to the reactor core by fixing the coolant inlet and outlet temperatures at reasonable values determined by previous studies. Author

**N65-12938#** Hanford Atomic Products Operation, Richland, Wash. Reactor and Fuels Lab.
**RADIATION EFFECTS IN SOME HANFORD REACTOR GRAPHITES**
S. S. Jones and E. M. Woodruff Jun. 1964 48 p refs
(Contract AT(45-1)-1350)
(HW-82152) OTS: $3.00

The effect of long-term reactor irradiation (up to 16 000 Mwd/At) on some physical properties of a group of nuclear graphites was studied. The physical properties investigated were dimension, electrical resistivity, thermal resistivity, apparent crystallite size, and crystallite lattice spacings. It was found that specimens cut parallel to the extrusion direction exhibited only contraction, which occurred at a linear rate throughout most of the exposure period. Perpendicular specimens initially

showed a small expansion, followed by a linear contraction at later stages. Electrical resistivity tended to saturate at very low exposures, and the level changed very little with further irradiation. Thermal resistivity also exhibited saturation but required higher exposures to reach a final saturation level and was temperature dependent, with partial annealing and a return to a second saturation level as the result of a 450° to 600° C temperature increase. The apparent crystallite size in both a and c directions decreased substantially with exposure, with no significant annealing effect from the temperature rise. Some evidence for such annealing action was found for the crystallite c-spacing measurements. The c spacing increased with exposure whereas the a spacing decreased at a somewhat lower rate. R.L.K.

**N65-12940#** Hanford Atomic Products Operation, Richland, Wash. Physics and Instruments Lab.
**PROGRESS IN NONDESTRUCTIVE TESTING: A SUMMARY OF HANFORD ACHIEVEMENTS IN THESE PROGRAMS UNDER GENERAL ELECTRIC, 1952–1964**
D. C. Worlton Aug. 1964 37 p refs
(Contract AT(45-1)-1350)
(HW-83608) OTS: $2.00

Nondestructive testing programs from 1952 to 1964 are reviewed. Following the chronological development of these programs, this report summarizes the fuel testing effort under which three separate, fully automatic inspection stations were developed and applied to the AlSi fuel processes to insure core, cladding, and closure integrity of each fuel element. Following beneficial use of these test systems, similar inspection equipment was developed and successfully applied to the N-Reactor fuel process; results of this program are also summarized. Long range research and development programs oriented toward the development of advanced ultrasonic, eddy current, thermal, and nuclear particle counting techniques were established as an outgrowth of the fuels effort, and progress under these programs is reviewed. Author

**N65-12950#** Atomics International, Canoga Park, Calif.
**LOW FLUX NUCLEAR RADIATION EFFECTS ON SEMICONDUCTOR DEVICES (BMI-LF-1)**
M. N. Robinson 1 Dec. 1964 199 p
(Contract AT(11-1)-GEN-8)
(NAA-SR-9684) OTS: $6.00

The first of a series of irradiation experiments on electrical and electronic devices intended for SNAP reactor-control systems is described. Four types of semiconductor devices, 2N744 and 2N1072 transistors, PS760 diodes, and 1N2032 Zener diodes, were irradiated to $10^{16}$ nvt (>0.1 Mev) and $4.5 \times 10^{8}$ R (gamma). Results are presented of in-pile measurements of the critical electrical characteristics, in the form of graphs produced automatically by a computer peripheral plotting facility. Author

**N65-12986#** Atomics International, Canoga Park, Calif.
**SNAP MERCURY RANKINE PROGRAM SNAP 2 STRUCTURAL EVALUATION PROTOTYPE SYSTEM (PSM-2)**
W. B. Gruenberg 1 Dec. 1964 81 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-9906) OTS: $1.65

This report defines the SNAP-2, PSM-2, Phase-II, prototype system program. The need for a structural test item is discussed, and the resulting objectives are presented. A summation of the design, fabrication, and assembly efforts is given. The test program is outlined, and some preliminary results are discussed. Author

**N65-13106#** Atomics International, Canoga Park, Calif.
**AEC UNCLASSIFIED PROGRAMS Quarterly Technical Progress Report, Jul.–Sep. 1964**
Dec. 1964 227 p refs
(Contract AT(11-1)-Gen-8)
(NAA-SR-10501) OTS: $6.00

This report on research in high-performance sodium-graphite reactor fuels and other components for a large advanced sodium-cooled power reactor contains the following subjects: "Sodium-Cooled Reactor Experiment"; "Large Sodium-Graphite Reactors"; "SCR Advanced Development"; "SCR Component Development"; "Fuel Surveillance"; "Separations Chemistry"; and "Advanced Development." G.G.

**N65-13174*#** General Electric Co., Cincinnati, Ohio. Missile and Space Div.
**POTASSIUM CORROSION TEST LOOP DEVELOPMENT Quarterly Progress Report No. 4, 15 Apr.–15 Jul. 1964**
E. E. Hoffman ed. 29 Oct. 1964 75 p refs
(Contract NAS3-2547)
(NASA-CR-54167) OTS Prices: HC $3.00/MF $0.75

The program to develop a prototype corrosion test loop for the evaluation of refractory alloys in boiling and condensing potassium environments is proceeding with the construction and operation of three Nb-1Zr test loops, each of which will be used in a sequence of component evaluation and endurance tests. Loop I, a natural convection loop to be used as the primary loop in the two-loop facility, was operated for 1000 hours with liquid sodium at 2260° to 2380° F and disassembled for metallographic examination. Construction has been completed of Loop II, a single-phase, forced-circulation loop that will be operated for 2500 hours with liquid sodium. Design changes were incorporated in the two-loop system, and fabrication has been initiated. D.S.G.

**N65-13189** Atomic Energy Commission, New Brunswick, N.J. New Brunswick Lab.
**ANALYSIS OF ESSENTIAL NUCLEAR REACTOR MATERIALS**
Clement J. Rodden, ed. Washington, AEC, 1964 1294 p refs
GPO: $4.25

This book is intended to provide the analytical chemist with information needed to carry out many analyses involved in nuclear technology without further literature searching. The materials included are uranium, plutonium, thorium, beryllium, alloys, ceramics, expended reactor fuels, graphite, boron, heavy water, reactor coolants, and trace elements. The methods discussed are spectrochemical methods, mass spectrometry, radiochemical and nuclear methods, electrometric methods, and X-ray spectroscopy. D.S.G.

**N65-13294#** Sandia Corp., Livermore, Calif.
**RE-ENTRY FLIGHT DEMONSTRATION NO. 1 (RFD-1): OPTICAL DATA AND FUEL-ELEMENT EXPERIMENT**
I. B. White, M. M. Robertson, B. W. Marshall, J. A. Allensworth, and H. L. Ivy Oct. 1964 143 p refs
(SC-RR-64-516) OTS: $4.00

This report on the RFD-1 optical data and external fuel-element experiment includes a description of the instruments and test components used, a presentation of the data obtained, an explanation of the methods of data reduction employed, and a statement of the conclusions derived. It covers the

theory, design, qualification tests, flight-test data, and results of the external fuel-element experiment. Also presented is a theoretical analysis of observed versus predicted ablation times and altitudes for the external fuel elements. Author

**N65-13303#** Du Pont de Nemours (E.I.) and Co., Aiken, S.C. Savannah River Lab.
**RADIATION PROPERTIES OF $^{244}Cm$ PRODUCED FOR ISOTOPIC POWER GENERATORS**
D. H. Stoddard, comp. Nov. 1964 22 p refs
(Contract AT(07-2)-1)
(DP-939) OTS: $2.00

The radiation properties of curium (~95 wt % $^{244}Cm$) that would be produced in a large-scale program are similar to the properties reported in the literature for pure $^{244}Cm$. The alpha, gamma, and neutron radiations associated with the $^{244}Cm$ product are presented for evaluation by users of $^{244}Cm$ as a heat source in isotopic power generators. Author

**N65-13314#** Douglas Aircraft Co., Inc., Newport Beach, Calif.
**PARTICLE DISINTEGRATION STUDY FOR RE-ENTERING NUCLEAR AUXILIARY POWER SYSTEMS Final Report**
F. E. Littman, L. E. Bell, R. R. Koppang, A. H. Malinovsky, and R. Silvestri Kirtland AFB, N. Mex., AF Weapons Lab., Sep. 1964 80 p refs
(Contract AF 39(601)-5004)
(AFWL-TDR-64-75; AD-607410) OTS: $3.00

The purpose of this study was to investigate the oxidation behavior of molten zirconium–10% uranium alloy particles in the presence of air or its components. A theoretical analysis of the aerodynamic and thermodynamic conditions affecting the droplets was carried out. The reaction of molten droplets of 50μ to 8000μ size with nitrogen, oxygen, and air was studied at pressures ranging from 3 to 760 torr. The results indicate that the particles of all sizes react more or less completely with the surrounding atmosphere. The reaction of the larger particles is quiet and smooth. The smaller droplets react with explosive violence, disintegrating into very small particles. Only in the latter case, which appears to be limited to particles initially smaller than 400μ does the reaction with air contribute to further decrease in particle size. Author

**N65-13324#** General Electric Co., Cincinnati, Ohio.
**HIGH-TEMPERATURE MATERIALS PROGRAM Progress Report No. 42, Pt. A, 15 Sep.–15 Nov. 1964**
18 Dec. 1964 30 p refs
(Contract AT(40-1)-2847)
(GEMP-42A) OTS: $2.00

A summary of work on the following specific research and development efforts is presented: (1) radiation effects in BeO—irradiation behavior of BeO in terms of the composition and microstructure variables that contribute to extended radiation stability; (2) fission gas diffusion in unfueled ceramic materials—diffusion of Kr, Xe, and I atoms in ceramic oxides MgO, BeO, $Al_2O_3$, and $ZrO_2$ subsequent to their injection via ion bombardment; (3) fission product transport processes in refractory metal fuel systems—Kr permeation through arc-cast tantalum; and (4) internal conversion ceramic fuel element research—chemistry involved in use of fertile material (thoria) in stabilized fuel–BeO systems. D.S.G.

**N65-13326#** Atomics International, Canoga Park, Calif.
**FUEL CLADDING FAILURE MONITOR FOR SODIUM REACTORS**
R. J. Hall, R. E. Avery, and E. A. Moore 1 Dec. 1964 28 p refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-6463) OTS: $0.50

Fuel cladding failures in the Sodium Reactor Experiment are detected as a result of the rapid increase in $Xe^{133}$ activity. A continuous reactor cover-gas circulating system and scintillation spectrometer form the major components of a fission product monitoring system. The fission product monitor can be employed to measure gross activity, perform a spectrum analysis of the reactor core gas, or measure the particular radioactive isotope in question. The scintillation spectrometer is capable of measuring $Xe^{133}$ activity down to a low concentration of $10^{-5}$ μc/cc with good resolution. Author

**N65-13331#** Hanford Atomic Products Operation, Richland, Wash.
**PROGRESS IN INSTRUMENTATION RESEARCH AND DEVELOPMENT: A SUMMARY OF HANFORD LABORATORIES ACHIEVEMENTS IN THESE PROGRAMS UNDER GENERAL ELECTRIC, 1951–1964**
D. C. Worlton, W. G. Spear, R. A. Harvey, G. E. Driver, J. T. Russell et al Oct. 1964 52 p refs
(Contract AT(45-1)-1350)
(HW-83606) OTS: $3.00

Highlights of instrumentation activities and technical achievements in nuclear instrumentation are summarized in the following areas: (1) radiological instrumentation—air contamination measurements, surface and general radiation monitoring methods, personnel monitoring instrumentation, and portable radiation survey; (2) biological instrumentation—*in vivo* radionuclide, biological field analysis, and data telemetry and control; (3) meteorological instrumentation—particle transport and solar measurements, and data telemetry and measurement system; (4) reactor instrumentation—neutron flux monitors, plutonium recycle test reactor, general reactor, and n-reactor instrumentation, and shielding; (5) chemical process instruments—spectrometers and conductivity; and (6) research instruments. Optical instrumentation, system analysis and analog simulation, and digital data and control systems are also discussed. P.V.E.

# 23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

**N65-12348#** Nihon U., Tokyo (Japan).
**ON A CLASSICAL SPINNING PARTICLE MODEL OF DIRAC PARTICLE**
Tetsuo Gotō [1964] 30 p refs
(NUP-64-15)

By using the "momentum proper time," which coincides with the usual time in the momentum rest frame, the general Lagrangian and Hamiltonian formalism of classical-relativistic spinning particles is developed. As an example of this formalism, a classical model is found that directly corresponds to Dirac and Duffin–Kemmer particles. In this example, differential operators that correspond to Dirac's γ-matrices are found. Author

**N65-12479#** Innsbruck U. (Austria). Inst. of Theoretical Physics
**SPINOR CALCULUS IN RIEMANNIAN MANIFOLDS Final Report, Aug. 1963–Aug. 1964**
F. Cap, W. Majerotto, W. Raab, and P. Unteregger 8 Oct. 1964 137 p refs
(Contract DA-91-591-EUC-2947)
(AD-451297)

This paper deals mainly with a consistent and largely general introduction of the spinor concept in the Riemannian space of general relativity. The transformation behavior of spinors is studied theoretically by groups in the most general manner. In this connection it is shown that spinors that are homomorphic to the full Riemannian transformation group cannot be found. Furthermore, the conclusion is drawn that spinor transformations are homomorphic to local Lorentz transformations. A two-dimensional linear complex vector space is erected in every point of the space. Thus, the spinor calculus is given a consistent basis. The theory is based on these developed expressions: $G = \bar{U}(H \otimes H)U$; $\bar{T}GT = G$, $\bar{S}HS = H$, where G is the tensor metric, H is the spinor metric, T is the tensor transformations (local Lorentz transformations), and S is the spinor transformations. Author

**N65-12529#** Harry Diamond Labs., Washington, D.C.
**PROJECTED ANGULAR MOMENTUM STATES**
N. Karayianis and C. A. Morrison 18 Sep. 1964 10 p refs
(HDL-TR-1252; AD-450155)

Wigner's group theoretic projection operator is used to construct certain total angular momentum states in terms of single-particle product wave functions. The group theoretic approach allows the simplification and generalization of results obtained by previous authors. Author

**N65-12533#** Grumman Aircraft Engineering Corp., Bethpage, N.Y.
**A PRELIMINARY DETERMINATION OF THE COEFFICIENTS OF FRICTION BETWEEN METALS AND NON-METALLIC SOLIDS IN ATMOSPHERIC AND HIGH VACUUM ENVIRONMENTS**
S. H. Penn Jul. 1964 25 p ref
(ADN-04-04-64.1)

The coefficient of friction between two metallic and two nonmetallic massive solids in atmospheric and vacuum environments was determined by a series of nine tests. The environmental conditions for this investigation were similar to those of a previous study during which granular specimens, instead of solids, were employed. The coefficients of friction determined during this investigation varied only slightly between pairs of interacting surfaces, whereas the values obtained with the granular tests varied more. As expected, the coefficients of friction were consistently higher in vacuo than in the atmosphere. Author

**N65-12547#** Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
**REDUCED DENSITY MATRICES OF QUANTUM GASES. III: HARD CORE POTENTIALS**
Jean Ginibre Oct. 1964 42 p refs

In two previous papers, the reduced density matrices of quantum gases, in the grand canonical formalism and for suitably restricted interaction potentials, have been shown to be analytic vector-valued functions of the activity in a neighborhood of the origin, to tend in some sense to well-defined limits as the volume of the system becomes infinite, and to satisfy a cluster decomposition property. The same results are extended in this paper, by use of the same methods, to a wider class of potentials, including hard core, and allowing previously excluded attractive interactions. Author

**N65-12636** United Kingdom Atomic Energy Authority, Harwell (Gt. Brit.) Electronics Div.
**CALCULATIONS OF ELECTRON TRANSIT TIMES IN TWO ELECTRON OPTICAL STRUCTURES**
P. Iredale London, HMSO, Aug. 1964 12 p refs
(AERE-M-1410) HMSO: 2s 6d

Simple calculations have been made of the transit times of electrons in an image converter with electrodes in the form of concentric spheres, and for a continuous channel type of electron multiplier. Author

**N65-12747#** Martin Co., Orlando, Fla.
**EXCITATION AND DETECTION TECHNIQUES FOR MILLIMETER WAVE TRANSITIONS Eighth Quarterly Progress Report, 1 Apr.–1 Jul. 1964**
J. J. Gallagher, R. G. Strauch, and R. E. Cupp Sep. 1964 58 p refs
(Contract DA-36-039-SC-90753)
(OR-6113; AD-447531)

Investigations on the electron bombardment ionizer have been performed with various gases. The molecular beam experiments that have been performed thus far are described. An interferometer has been employed in the ammonia maser. Amplification, but as yet no oscillation, has been observed. The sign of the molecular g-factor for $H_2S$ has been measured. The dipole moment of $H_2S$ has been determined from both electric resonance experiments and waveguide Stark spectrometer studies. Calculations of the first-order centrifugal distortion in the HDS rotational spectrum are discussed. Author

**N65-12856#** Yale U., New Haven, Conn.
**[HYDRODYNAMICS OF LIQUID HELIUM] Annual Summary Report, 1 Oct. 1963–30 Sep. 1964**
C. T. Lane [1964] 7 p
(Contract Nonr-609(33))
(AD-607075) OTS: $1.00

Research on persistent hydrodynamic currents in helium II is reported as part of a study of the angular momentum of liquid helium contained in cylindrical vessels having both simply and multiply connected geometries. Experimental proof is presented showing that long lifetime currents actually exist in He II that are analogous to electron currents due to pairs in superconductors, and that the curl $v_s=0$, where $v_s$ is the velocity field of the superfluid. Efforts to show a difference in the rotational state of liquid helium due to the presence of the Onsager–Feynman quantitized vortices are reported. A technique for producing extremely uniform time-invariant fields using a short conventional solenoid with a superconducting tin core is described. Equipment being developed includes an apparatus to detect persistent currents in He II based on their gyroscopic effect, and an apparatus for the vacuum deposition of thin films of various superconductors in a variety of geometrical shapes. M.P.G.

**N65-12857#** Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
**OPTICAL MODEL AND ANALYTICITY IN MOMENTUM TRANSFER**

K. Chadan Nov. 1964 8 p refs
(TH-73)

It is shown that in the Omnes method of calculating the optical potential from the scattering amplitude at high energies, the requirement of Mandelstam analyticity in cos $\theta$-plane can be replaced by that of analyticity inside an ellipse. Author

**N65-12860#** Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
**PHENOMENOLOGICAL DESCRIPTION OF THE RELATIVISTIC NEUTRON-PROTON-DEUTERIUM VERTEX**
M. Gourdin, M. le Bellac, F. M. Renard, and J. Tran Thanh Van Oct. 1964 32 p refs
(TH-69)

The neutron–proton–deuterium vertex is studied so as to define a covariant generalization of the characteristic wave functions S and D of deuterium. The vertex functions are shown to satisfy a spectral relation, and a phenomenological expression is obtained by replacing the cut in the dispersion integrals by a series of poles. The sets of possible parameters are determined beginning with the static properties of deuterium and the experimental results on the photodisintegration of deuterium. M.P.G.

**N65-12890#** Ohio State U., Columbus. Engineering Experiment Station
**EQUATIONS FOR FOUR-BAR LINKAGE FUNCTION GENERATORS**
Charles W. McLarnan [1963] 96 p refs *Its* Bull. No. 197
Available from Ohio State U.: $3.00

This report presents a collection of equations for the synthesis of four-bar linkage function generators in cases where either three, four, or five conditions are placed on the input and output rotations, or their derivatives. A total of fifteen possible cases are presented. G.G.

**N65-12894#** Philips Gloeilampenfabrieken, N.V., Eindhoven (Netherlands). Philips Research Labs.
**PARTITION EFFECTS IN TRANSVERSE ELECTRON-BEAM WAVES**
P. A. H. Hart (Ph.D. Thesis, Tech. Hogeschool, Eindhoven) 1964 61 p refs *Its* Philips Res. Rept. Suppl.-4

Four, independent, transverse waves are possible on a beam focussed by an axial magnetic field. A theory is presented describing the attenuation of the transverse modulation of the beam and the noise generated if part of the beam is intercepted or scattered, or if there is spread in axial electron velocity. To represent the beam having a finite cross section the "disk" model has been used. The generation of noise is shown to be proportional to the attenuation of the original waves and to the beam's internal temperature. Moreover, the noise waves generated appear to be partly correlated. The theory has been verified experimentally in case of interception and scattering for the fast cyclotron wave and both the positive- and negative-energy synchronous waves. Measurements with the fast cyclotron wave by means of modified Adler–Wade tube are in good agreement with the theory. The theory also predicts satisfactorily the attenuation of both synchronous waves and the noise generated in the negative-energy synchronous mode. Author

**N65-12945#** Atomic Energy of Canada Ltd., Chalk River, Ontario.
**PHYSICS DIVISION PROGRESS REPORT, JULY 1–SEPTEMBER 30, 1964**
L. G. Elliott et al [1964] 64 p refs
(PR-P-63; AECL-2108) Available from Atomic Energy of Canada, Chalk River: $1.50

Progress is reported in the following areas: (1) nuclear physics research—development of a new method of measuring lifetimes of excited nuclear states using lithium-drifted germanium gamma-ray detectors, and use of an improved beam-switching and data-recording system at the tandem accelerator; (2) solid-state studies—analysis of normal vibrations in single crystals of lead telluride and of stoichiometric uranium dioxide for three directions of high symmetry using a triple-axis crystal spectrometer; (3) developments in solid-state radiation detectors; and (4) computer programing for two-group neutron-diffusion calculations for a three-dimensional model of a reactor with a hexagonal lattice. M.P.G.

**N65-12947#** Johns Hopkins U., Baltimore, Md.
**X-RAY WAVELENGTHS Final Report**
J. A. Bearden Oak Ridge, Tenn., AEC, 1964 540 p refs
(Contract AT(30-1)-2543) OTS: $8.45

The results of remeasurement of selected X-ray lines and reevaluation of all published wavelengths on both a consistent and absolute scale are presented in two tables. Table I lists the wavelength values in angstroms, records both a relative and an absolute probable error, gives the energy of the line in keV, and the value of $(\nu/R)^{1/2}$ for each element. The table is divided into five sections: K series, L series, M series, N and O series, and absorption edges. The lines under each element are further divided into two groups: electric dipole lines and higher order lines. The lines under each f group are listed in alphabetic order by transition. The wavelengths are based on W $K_{\alpha 1}$ = 0.209 010 0 as a standard reference value. In table II the same data as in table I with the exception of $(\nu/R)^{1/2}$ are presented and arranged according to the numerical order of the wavelengths. The appendix gives a summary of all the original data and the procedure used for obtaining the adopted wavelength values in xu based on W $K_{\alpha 1}$ = 208.5770 xu, which was used as a preliminary working standard. A bibliography of approximately 400 papers used in evaluating the wavelength values is included. P.V.E.

**N65-13068#** Hayes International Corp., Birmingham, Ala.
**A STUDY OF THE RADIATIVE CHARACTERISTICS OF SHIELDED INFRARED SOURCES Final Engineering Report No. 649, Jun. 1963–Jan. 1964**
Ned D. Gilliam and James L. Reid Ft. Eustis, Va., Army Transportation Res. Command, May 1964 101 p refs
(Contract DA-44-177-TC-805)
(TRECOM-TR-64-25; AD-608514)

Two ray-tracing programs for digital computers were written to predict the angular distribution of radiant intensity from an infrared source when shielded by a variety of cold shields. Studies were conducted on two computers, an IBM 1620 and an IBM 7094. The results of 16 runs on the 1620 and 7 runs on the 7094 are presented in tabular and graphical form and are compared with laboratory measurements. An analytical approach was developed for predicting directional radiant intensity from shielded infrared sources. Solutions to the integral equations for radiative transfer are used to develop a prediction formula for diffuse and for specular surfaces. The prediction formula was applied to diffuse configurations, both with and without a spherical innerbody, and the results were compared with laboratory measurements of a similar set of configurations. Qualitative agreement was found to exist for these configurations that were directly comparable. P.V.E.

**N65-13154#** State U. of Iowa, Iowa City.
**DATA ACQUISITION AND REDUCTION Final Report**
Royce E. Beckett Aug. 1964 12 p
(Contract DA-11-070-508-ORD-1232)
(Rept.-13; AD-607203)

Abstracts of nine Data Acquisition and Reduction reports are presented to summarize the work done in this program. The subtitles of the included reports are: "An Evaluation of Instrumentation for Measuring the Behavior of a Rocket Launcher in Laboratory Tests During a Firing"; "Analysis of Data Traces of Very Short Duration"; "Variations of the Trajectory of an Unguided Rocket Caused by Statistical Variations in Parameters"; "Response of a Launcher Understructure during Simulated Rocket Loading"; "Balloting Phenomena in Rocket Launcher Firings"; "Feasibility Study for Reduction and Analytic Approximation of Data Records"; and "Prediction of Results of an Event from Sample Data Analysis." D.S.G.

**N65-13208#** Indiana U., Bloomington. Chemical Lab.
**A SELF SUSTAINING DIPOLE DISCHARGE IN OXYGEN**
Nguyen Trinh Dzoanh *In its* Appl. of Ionic Beams to Study of Corrosion of Metals by Gases Oct. 1964 31 p refs (See N65-13206 03-26)

Two, parallel metal electrodes are covered with porous insulating layers and immersed in oxygen at one atmosphere pressure. A dc potential difference of about 15 kV is applied between the plates, which are several cm apart. When a 200-microcurie alpha-particle source (Polonium-210) is introduced between the plates, an electric discharge is initiated that continues for 1 or 2 hours after the source is withdrawn. This discharge is called the self-sustaining dipole discharge. Its origin is believed to be a Malter effect occurring simultaneously at both electrodes, and caused by microspark discharges in the pores of the insulating layers. This mechanism is supported by the observation that tiny particles of insulating material may be ejected during the discharge. Author

**N65-13339#** RAND Corp., Santa Monica, Calif.
**GREEN'S FUNCTIONS FOR ONE-VELOCITY NEUTRON TRANSPORT IN A ONE-DIMENSIONAL SLAB AND SPHERE**
A. Leonard and T. W. Mullikin Aug. 1964 17 p refs
(Contract AF 49(638)-700; Proj. RAND)
(RM-4206-PR; AD-604461) OTS: $1.00

This memorandum presents an exact and efficient method of computing a well-defined resolvent, or Green's function, for one-velocity neutron transport or radiative transfer in a one-dimensional slab or sphere with isotropic scattering. The resolvent for the slab may be simply expressed in terms of a "complex valued" solution to the transport equation, using the Laplace transform and contour deformation. The procedure for computing this solution by means of simple quadratures and rapidly convergent Fredholm equations is given. The result for the sphere resolvent, which is closely related to that for the slab, is also presented, with particular attention to the flux resulting from a point source in the center of a sphere. Author

# 24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

**N65-12338#** Atomic Energy of Canada Ltd., Chalk River, Ontario.
**ON THE SOLUTION OF THE INTEGRAL BOLTZMANN EQUATION IN CYLINDRICAL GEOMETRY**
D. C. Sahni Sep. 1964 47 p refs
(CRRP-1201; AECL-2083) Available from Atomic Energy of Canada, Chalk River: $1.50

The solution of the steady-state integral Boltzmann equation for the neutron flux is considered in a two-region cylindrically symmetric system. The inner region is a scattering and absorbing medium that may also contain isotropic sources. The outer region is purely scattering and is source-free except for a total net current of neutrons at infinity. A method for solving the equation is discussed. In particular it is shown that a solution exists only for one value of a-parameter, the extrapolation distance, which also satisfies the requirement of neutron conservation. Exact numerical determination of the extrapolation distance and flux is carried out in the particular case when the total cross sections of two media are equal. Some applications to the finite medium problem (i.e., the cell problem) have also been considered in this special case. Author

**N65-12346#** Research Inst. of National Defence, Stockholm (Sweden).
**OPTICAL MODEL ANALYSIS OF NEUTRON ELASTIC SCATTERING FROM NITROGEN**
B. Johansson Oct. 1964 18 p refs
(C-4183-411)

Optical-model calculations of neutron scattering for the nucleus $N^{14}$ were made. The energy region that was examined was 4.5 to 11.6 MeV. At the lower energies, use was made of the Hauser–Feshbach formalism in order to estimate the compound elastic scattering. Reasonable fits were obtained, especially at higher energies. Author

**N65-12347#** Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
**ON THE POSSIBILITY OF CP VIOLATION IN THE $K\pi_3$ DECAY**
Mary K. Gaillard Oct. 1964 11 p refs

The theoretical possibility of a large CP violation in $K \rightarrow 3\pi$ decays is outlined. Any CP violation in the decay matrix elements should give rise to a nonvanishing imaginary part in the mass matrix. However, since this imaginary part cannot be evaluated, the possibility is examined that a large violation of CP in some processes (e.g., in leptonic decays or in the $3\pi$ mode) does not necessarily imply a large imaginary part in the mass matrix element. It is concluded that this indicates that an arbitrary phase for these decays should be assumed *a priori*. In considering the $3\pi$ decay mode, an investigation was carried out to determine whether or not a large phase is consistent with present experimental data, and an attempt is made to show that such an effect, if present, has a directly observable consequence. P.V.E.

**N65-12427#** Rochester U., N.Y.
**SOME CONSEQUENCES OF POSSIBLE QUADRATIC INTERMEDIATE VECTOR BOSON INTERACTIONS WITH HADRONS**
S. V. Pepper, C. Ryan, S. Okubo, and R. E. Marshak 16 Oct. 1964 36 p refs
(Contract AT(30-1)-875)
(UR-875-60)

Some consequences are investigated of a hypothesis that the intermediate vector boson, which is supposed to be responsible for the weak interactions, may have strong quadratic interactions with the nucleon. No contradiction is found with the existing experimental data, if the mass of the vector boson is greater than 2.5 BeV. In this scheme it is possible to explain the small difference between renormalized vector-coupling constants of $\beta$ and $\mu$ decays. Some experiments are suggested to test the validity of the postulated strong quadratic interaction. Author

**N65-12506*#** National Bureau of Standards, Washington, D.C.
**TABLES OF ENERGY LOSSES AND RANGES OF ELECTRONS AND POSITRONS**
Martin J. Berger and Stephen M. Seltzer Washington, NASA, 1964 131 p refs
(NASA Order R-80)
(NASA-SP-3012) OTS Prices: HC $4.00/MF $1.00

Tables are presented for approximately forty materials and for eighty energies between 10 keV and 1000 MeV, which contain the following information: mean energy loss of electrons by collisions with atomic electrons and by bremsstrahlung, the mean range, and the radiation yield (conversion of electron kinetic energy into bremsstrahlung energy). Auxiliary tables contain information about restricted collision losses in water, critical energies (at which the collision and bremsstrahlung losses are equal), and electron–positron differences in regard to energy loss and range. Some comparisons are made between calculated and experimental values of the mean energy loss. Author

**N65-12507*#** National Bureau of Standards, Washington, D.C.
**TABLES OF ENERGY LOSSES AND RANGES OF HEAVY CHARGED PARTICLES**
Walter H. Barkas and Martin J. Berger (Lawrence Radiation Lab., Calif. U., Berkeley) Washington, NASA, 1964 132 p refs
(NASA Order R-80)
(NASA-SP-3013) OTS Prices: HC $4.00/MF $1.00

Two-variable proton stopping-power and range tables are given as functions of the particle energy $\tau$ and of the mean excitation energy $I_{adj}$ of the medium for 160 values of $\tau$ between 1 and 5000 MeV, and for 36 values of $I_{adj}$. The tabulated values below 8 MeV are based on experimental stopping-power and range data as summarized by a 9-parameter least-squares range formula. Above 8 MeV they are based on the Bethe stopping power theory, except for the shell corrections, which are calculated by an empirical formula in the variables $\tau$ and $I_{adj}$ derived from the analysis of experimental data. The two-variable tables do not include the density effect correction that begins to be appreciable when the kinetic energy of the particle is approximately equal to the rest mass. Stopping-power and range tables that include the density effect correction are given for protons, kaons, pions, and muons, for 36 elements and compounds. Author

**N65-12546** European Organization for Nuclear Research, Geneva (Switzerland). Proton Synchrotron Machine Div.
**MONTE CARLO CALCULATION OF THE NUCLEON-MESON CASCADE IN SHIELDING MATERIALS INITIATED BY INCOMING PROTON BEAMS WITH ENERGIES BETWEEN 10 AND 1000 GeV**
J. Ranft 18 Nov. 1964 70 p refs
(CERN-64-47)

The Monte Carlo method was used in analytical calculations of the three-dimensional development of a nuclear cascade. The calculations for the energies of the incoming protons $E_0$ between 10 and 1000 GeV were carried out and compared with the corresponding experimental studies of the cascade propagation for $E_0$ = 10 and 20 GeV, which were performed with the help of beams of limited cross sections. Reasonably good agreement was found. All calculations were made for steel as the shielding material, but the development of the cascade in other materials seems to be analogous. G.G.

**N65-12557#** Aerospace Corp., El Segundo, Calif. Lab. Operations
**EFFECT OF EXTERNAL HEAVY ATOMS ON DECAY PROCESSES FROM THE TRIPLET STATE**
Seymour Siegel and H. S. Judeikis 16 Nov. 1964 37 p refs
(Contract AF 04(695)-469)
(SSD-TDR-64-178; TDR-469(5250-30)-2; AD-452240)

An investigation was made to determine the relative sensitivities to the external heavy atom perturbation of the radiative ($k_p$) and the nonradiative ($k_{qp}$) decay constants for the return of aromatic molecules in their first triplet state to the ground state. The investigation was carried out in glasses at 77° K using alkyl halide and ethanol mixtures as solvents. A combination of epr and optical emission spectroscopy was used as the diagnostic technique. The results of the study show that $k_p$ is more sensitive than $k_{qp}$ to the nature of the heavy atom in the solvent. It is also found that $k_{IS}$ (the intersystem crossing rate constant) is less sensitive than $k_p$ to the heavy atom perturbation. Finally, analysis of the data indicates not only that $k_{qp}$ is not totally quenched upon perdeuteration of naphthalene but also that $k_{qp} > k_p$ in naphthalene-$d_8$ in ethanol. Author

**N65-12682#** Naval Radiological Defense Lab., San Francisco, Calif.
**HEAVY ION TRACKS IN NUCLEAR EMULSIONS: APPLICATIONS TO CHARGED PARTICLE DOSIMETRY**
E. V. Benton and E. Tochilin 11 Aug. 1964 17 p refs
(USNRDL-TR-773; AD-449649)

Nuclear research emulsions, Ilford K.5, K.2, K.0, K minus 1, and K minus 2 were exposed to 10 MeV/nucleon heavy ion beams consisting of $A^{40}$, $Ne^{20}$, $O^{16}$, $N^{14}$, and $C^{12}$ having rates of energy loss in the range 0.35 to 5.2 MeV/micron. All emulsions of a given sensitivity were taken from a single batch and were exposed and processed at one time in order to permit intercomparison between tracks of the different ions in the five types of emulsions are presented. Relative merits of the various emulsions are discussed, as well as possible applications to heavy-ion charged-particle dosimetry. Author

**N65-12794*#** Geophysics Corp. of America, Bedford, Mass.
**PLANETARY PHYSICS. IV: AN EXPANSION METHOD FOR CALCULATING ATOMIC PROPERTIES. I: THE $^2S$ AND $^2P^0$ STATES OF THE LITHIUM SEQUENCE**
M. Cohen and A. Dalgarno [1964] 31 p refs
(Contract NASw-840)
(NASA-CR-57010; GCA-TR-64-5-N) OTS Prices: HC $2.00/MF $0.50

An expansion method is used to calculate the expectation values of various operators for the lowest $^2S$ and $^2P^0$ states of all members of the lithium sequence. The method is extended to the calculation of matrix elements connecting the two states, and the electric dipole transition integrals are calculated. A comparison with the results of more refined calculations shows that despite its simplicity the method is capable of high accuracy. Author

**N65-12916#** Queens U., Belfast (Northern Ireland).
**CONFIGURATION INTERACTION IN MAGNESIUM**
R. J. S. Crossley [1964] 24 p refs
(Grant AF-EOAR-63-85)
(AFCRL-64-875; AD-608488)

Zero-order eigenfunctions and first-order energies are obtained in the hydrogenic Z-expansion scheme for magnesium-like systems. Full account is taken of configuration interaction arising in Russell–Saunders coupling. Special attention is given to the configuration pd and to problems of phase. Author

**N65-12935#** Air Force Cambridge Research Labs., Bedford, Mass. Solid State Sciences Lab.
**PHYSICS OF THE MOSSBAUER EFFECT Physical Sciences Research Papers No. 58**
Leonard J. Eyges Oct. 1964 42 p refs
(AFCRL-64-840; AD-608780)

This paper discusses the kinematics of gamma-ray emission from a nucleus bound in crystal lattice. The idealized case of a massive lattice characterized by a single frequency and the more realistic one and three-dimensional models are treated. In the Mössbauer effect the lattice as a whole (the lattice center of mass) always recoils after photon emission. The essence of the Mössbauer effect is photon emission without transfer of energy to internal degrees of freedom of the lattice. Using the rules for the manipulation of probability amplitudes (the so-called transformation theory), the probability for recoil without excitation of internal degrees of freedom is calculated—i.e., the Mössbauer f-factor, on the assumption that the individual photon emissions and consequent lattice recoil are instantaneous. The question of instantaneous emission is not in contradiction with the fact that the nuclear transition that leads to the gamma-ray emission has a finite half-width. Rules of transformation theory are summarized. Author

**N65-12985#** Nihon U., Tokyo (Japan). Coll. of Science and Engineering
**REFORMULATION OF SENIORITY SCHEME WITH ISOSPIN**
Munetake Ichimura [1964] 41 p refs
(NUP-64-16)

In a previous paper, many-nucleon states in the shell model are characterized through the group $C_2$, used for an exact treatment of charge-independent pairing interaction. This scheme was proved to be equivalent to Flowers' seniority-reduced-isospin scheme. The matrix elements of a pair creation operator (a generator of the group $C_2$) are connected with the coefficients of fractional parentage (cfp) of the type

$$[j^{n-2}(\beta_1 vt T_1 \alpha J)j^2(T = 1\ J = 0)|\}j^n\ \beta vt\ T\ \alpha],$$

which play an essential role in seniority scheme. A simple method of calculation of the matrix elements of a pair operator is developed, and the elements are tabulated up to $\lambda_1 + \lambda_2 \leq 4$ (complete for up to $f_{7/2}$ shell). A recursion formula of cfp in seniority scheme is derived, which is more general than that of de-Shalit and Talmi. Author

**N65-13063** European Organization for Nuclear Research, Geneva (Switzerland). MSC Div.
**AZIMUTHAL DISTRIBUTION OF BEAM LOSSES IN A CYCLOTRON WITH AN INTERNAL TARGET, TAKING MULTI-TRAVERSALS INTO ACCOUNT**
M. Barbier and C. Perret 4 Nov. 1964 34 p refs
(CERN-64-45)

A series of graphs presents data on the azimuthal distribution of beam particle losses in a cyclotron for the case when the cyclotron is operated with an internal target. Results presented lead to conclusions concerning activation, shielding, and target efficiency. The protons scattered by the target get lost in the first quarter of a betatron oscillation wavelength. The maximum of beam deposit occurs at about one-eighth of a wavelength downstream from the target. In the cyclotron considered, the dee acts as the main beam dump. It was also found that the fraction of the beam reacting in the target is always less than 10%. D.E.W.

**N65-13116#** Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
**HIGHER ORDER BOSON-LEPTON WEAK INTERACTIONS IN THE LADDER GRAPHS APPROXIMATION**
S. Badier and C. Bouchiat Nov. 1964 39 p refs
(TH-71)

The theory of peratization, which consists of summing up the perturbation series for a finite value of the regulating mass (cut-off variable) and continuing by prolonged analysis to the limit where the cut-off goes to infinity, is applied to boson–lepton scattering. It is assumed that the weak boson–lepton interaction of the type V–A was transferred by a boson vectorial W. The summation, which holds only for the diagrams on an uncrossed ladder graph, has been carried out in solving the Bethe–Salpeter equation. The higher order terms also calculated give a contribution of the same order as the Born term. At zero momentum transfer, the effect of the higher order terms is to multiply the Born amplitude $i_g^2/m_w^2$ by a factor of 9/8, which is different from the factor 3/4 obtained by a similar calculation for lepton–lepton and baryon–lepton scattering. Trans. by M.P.G.

**N65-13178#** Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati
**CHANGE OF THE MOBILITY OF POSITIVE IONS IN ROTATING HELIUM II**
I. Modena, A. Savoia, and F. Scaramuzzi 9 Oct. 1964 7 p refs Presented at the 9th Conf. on Low Temp. Phys., Columbus, Ohio, 1964 Submitted for Publication *Its* Nota Interna no. 260
(LNF-64/49)

The results of experiments on the influence of rotation on the motion of ions in superfluid helium are discussed. The apparatus used consisted of a diode, whose emitting electrode was plated with $Po^{210}$, and which emits alpha-particles of 5.3 MeV. The particles intensely ionize the liquid in a very thin layer adjacent to the source. The current passing through the diode is measured as a function of the applied potential. In particular, the extension of the measurements of completely space-charge-limited currents to the case of positive ions is discussed. A graph is presented showing an i vs $V^2$ plot for positive and negative ions with and without rotation. For positive currents in rotation the plot is a straight line, whereas the plot for negative ions in rotation is not. It is concluded that the current changes produced by rotation on positive ions, though smaller than those for negative ions, can be explained in a more straightforward manner and can perhaps afford useful information on the character of vorticity. P.V.E.

**N65-13182#** Mound Lab., Miamisburg, Ohio.
**DETERMINATION OF COINCIDENCE CORRECTIONS IN A PROPORTIONAL COUNTER II. THE KNOWN HALF-LIFE METHOD**

H. W. Kirby and J. Z. Braun 27 Nov. 1964 17 p refs
(Contract AT-33-1-Gen-53)
(MLM-1202)

Serious objections to the known half-life method for determining coincidence corrections are illustrated using lead-211 (actinium B) as the radioactive nuclide. It is shown that the customary semilogarithmic plot can yield only approximate corrections, and that the alternative of computing the resolution time by the method of least squares is highly sensitive to the method of weighting the data, to the accuracy with which the assumed half-life is known, to the counting range used in the determination, and to the validity of the expression relating observed and true counting rates. The computed probable errors do not reflect the uncertainty in the "known" half-life determination since the resolution time is imperfectly known. It is concluded that the half-life of a short-lived radioisotope and the resolution time of a counting instrument should therefore be treated as interdependent parameters.

D.S.G.

**N65-13185#** Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
**INELASTIC ELECTRON SCATTERING**
M. Gourdin Oct. 1964 16 p refs
(TH-65)

The general structure of the inelastic electron-scattering differential cross section is given, in a first electromagnetic Born approximation, for an arbitrary number of final particles. Particular attention has been given to the limiting case of a real photon and of elastic scattering. Trans. by M.P.G.

**N65-13190#** Argonne National Lab., Ill.
**NUCLEAR SPECTROSCOPY WITH DIRECT REACTIONS. II: PROCEEDINGS**
F. E. Throw, ed. Mar. 1964 544 p refs Symp. held at Chicago U., 9–11 Mar. 1964
(Contract W-31-109-ENG-38)
(ANL-6878) OTS: $5.50

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**N65-13193#** Princeton U., N.J. Elementary Particles Lab.
**A STUDY OF THE $K^+$ LIFETIME AND THE LONGITUDINAL POLARIZATION OF THE MUON IN $K^+_{\mu 2}$ AND $K^+_{\mu 3}$ DECAY**
Carroll A. Quarles, Jr. (Ph.D. Thesis) 21 Sep. 1964 99 p refs
(Contract Nonr-1858(06))
(TR-36; AD-606994)

Lifetime data were checked for deviations from a pure exponential decay law. No evidence was found for such deviations and the following mean lives were determined: $\tau(K^+)$ = (12.443 ±0.038) nanoseconds, and $\tau(K^+_{\mu 2})$ = (12.501 ±0.087) nanoseconds. The longitudinal polarization of the in $K^+_{\mu 2}$ decay was −1.01 ±0.12. The muon is essentially 100% polarized with its spin antiparallel to its momentum in agreement with the assumptions of spin zero for the $K^+$ and tne two-component theory of the neutrino. For the longitudinal polarization of the muon in $K^+_{\mu 3}$ decay, P = +0.7 ±0.6 at a muon energy of (191 ±4) Mev and P = −0.6 ±0.7 at

(231 ±4) Mev were found. These data, taken together with other recent measurements of this polarization, are consistent with the constant form-factor theory with $\xi = 0.5$ and with a partially conserved strangeness changing vector current theory. Author

N65-13218# India. Dept. of Atomic Energy, Bombay.
**PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, 1964. PART A: NUCLEAR PHYSICS**
[1964] 334 p refs Eighth Ann. Symp. held at Panjab U., Chandigarh, India, 24–28 Feb. 1964

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# 25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

**N65-12381#** Aerojet-General Nucleonics, San Ramon, Calif. Research Div.

**APPLICATION OF DISTRIBUTED CHARGE EXCHANGE TO A CROSSED-FIELD ACCELERATOR**

J. L. Wyatt and W. B. Day *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 47–68 ref (See N65-12379 03-34)

This paper presents an analysis of the technique of distributed charge exchange, as an alternative to elastic collisions, for exchanging momentum between a plasma and a neutral gas for the E × B accelerator. In order to develop this concept thoroughly a somewhat different approach to the E × B accelerator is used. It is shown that proper adjustment of plasma density, background neutral particle density, and electric and magnetic fields can produce a continuous high-velocity stream of neutral particles useful in many E × B accelerator applications. Author

**N65-12382#** Oklahoma U., Norman.

**THEORY OF RAREFACTION WAVES IN A PLASMA**

G. W. Paxton and R. G. Fowler *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 69–108 refs (See N65-12379 03-34)

A theory for the rarefaction process in a plasma carrying an electric current is developed for the one-dimensional case. General criteria are derived that determine the nature of the rarefaction process as a function of the electron temperature and degree of ionization in the plasma. The analysis shows that under certain conditions the rarefaction wave is a rarefaction shock. The theory is applied to the rarefaction wave in the driver section of the electric shock tube in order to determine the velocity of the compressional shock produced in terms of the electron temperature, degree of ionization, and plasma density in the driver section. Author

**N65-12383#** Rolls-Royce Ltd., Littleover (Gt. Brit.) Advanced Research Dept.

**BLAST WAVE AND CHARACTERISTICS ANALYSIS OF THE FLOW IN AN ELECTROMAGNETIC TEE-TUBE**

D. C. Dryburgh *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 109–161 refs (See N65-12379 03-34)

The theory of characteristics and the blast-wave theory have been applied to assess the degree of nonuniformity in the flow experienced at a fixed position behind the decaying shock wave in an electrically driven Tee-tube. The results agree well, the residual discrepancies being due in part to the deviation of the shock from an ideal blast wave, and in part to an error in the blast-wave solutions. Characteristics theory, though more involved than blast-wave theory, may be applied more generally, and the modifications necessary to use the method of characteristics with a gas in ionization equilibrium are described. Author

**N65-12384#** Aix-Marseilles U. (France). Institut de Mecanique des Fluides

**FUNDAMENTAL RESEARCH ON THE PLASMAS IN A MAGNETOHYDRODYNAMIC SHOCK TUBE [RECHERCHES FUNDAMENTALES SUR LES PLASMAS DANS UN TUBE A CHOCS MAGNETRODYNAMIQUE (MHD)]**

R. M. Head, J. Valensi, and Y. Charvet *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 163–245 refs In FRENCH (See N65-12379 03-34)

The light front velocity in an MHD shock tube was observed by linear light-beam scanning and image presentation onto the mirror of a movie camera. Velocity variations by modifications of the parameters were investigated for the following gases: air, helium, hydrogen, and argon. Discontinuities caused by the oscillatory nature of the discharge in the cone-shaped tube were observed, particularly on the curves representing the light front velocity as a function of the initial pressure when all the other parameters were kept unchanged. The velocity measurements made under these conditions were judged to yield the velocity of the shock wave. Spectrographic measurements of the relative intensities, the expansion, and the spectrum line displacements due to the doppler effect were performed of the spectral lines emitted by various atoms and ions in various excitation states, but all spectra obtained were found to be time integrated. G.G.

**N65-12385#** ARO, Inc., Arnold Air Force Station, Tenn.

**TRANSIENT ELECTRICAL CHARACTERISTICS OF INDUCTANCE-DRIVEN ARC DISCHARGES IN HIGH DENSITY NITROGEN**

Rex R. Walker, III and Jack D. Whitfield *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 247–276 refs (See N65-12379 03-34)

(Contract AF 40(600)-1000)

Transient inductance-driven arcs in the current regime of from $10^4$ to $5 \times 10^5$ A have been used for a number of years to heat nitrogen gas used in intermittent hypersonic wind tunnels. In this paper an analytical representation of an arc discharge is developed by accounting for experimentally observed variations of arc voltage with current. The developed semiempirical theory provides a basic tool for many possible uses, such as scaling power-supply requirements, scaling arc-chamber requirements, and predicting arc-heating performance for different initial gas densities, electrode gaps, and arc chamber geometries. The agreement between the developed semiempirical theory and experiment is reasonable in the arc current regime of $10^4$ to $5 \times 10^5$ A. Author

**N65-12386#** Electro-Optical Systems, Inc., Pasadena, Calif. Fluid Physics Div.

**A SURVEY AND PREDICTION OF THE PERFORMANCE CAPABILITY OF COAXIAL ARC HEATERS**

G. L. Cann and R. D. Buhler *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 277–321 refs (See N65-12379 03-34)

(Contract AF 33(657)-7940)

To estimate the ultimate technical limits of arc-gas-heater performance, the well-known approximate theories for the fully developed arc column (parabola and Bessel models) were extended to include radiation and for the high-current regime, the self-magnetic pressure gradient. Hot-gas containment limits (highest radially averaged outlet enthalpy vs pressure) were calculated for air, for a range of allowable wall heat loads (0.1 to 10 $kW/cm^2$). This resulted in a predicted absolute technical limit of continuous hot-gas containment independent of size, within the pressure-size range of the optically thin gas approximation. Author

**N65-12391#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**EFFECT OF AXIAL FLOW ON THE BEHAVIOR OF THE WALL-CONSTRICTED ARC**

Howard A. Stine, Velvin R. Watson, and Charles E. Shepard *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 1 Sep. 1964 p 451–485 refs (See N65-12379 03-34)

An experimental and theoretical study of the interaction between an electric arc and a coaxial flow of gas has been carried out in a range of size, enthalpy level, and pressure level where radiation heat loss is a noticeable portion of the total loss from the system. Numerical calculations have been performed and have been compared with earlier analytic calculations and also with the experimental results. Although differences in the detailed behavior of the gas flow–arc interaction are predicted by the two theoretical methods, the integrated behavior as deduced by either of the theoretical methods is essentially the same. Moreover, this integrated behavior is in substantial agreement with the experimental results, at least insofar as predictions of buildup of energy flux are concerned. Author

**N65-12394#** Aerospace Research Labs., Wright-Patterson AFB, Ohio.

**RADIATION FROM AN ALTERNATING CURRENT NITROGEN ARC**

P. W. Schreiber *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 515–584 refs (See N65-12393 03-34)

An experimental investigation of the total power radiated per unit length from a nitrogen arc operating on alternating and direct current is outlined, and sample results are given. The measured results include average and instantaneous radiant power, average electrical power, root mean square and instantaneous current and voltage, arc radii, spectra, and average absorption, as well as flow parameters, such as total mass flow rate and vortex strength. In addition, radiometer calibration techniques and the sources of error are discussed. Author

**N65-12395#** General Electric Co., Philadelphia, Pa.

**REAL GAS RADIATION WITH SELF-ABSORPTION AND SPACE VARYING TEMPERATURE**

C. H. Marston and T. K. Pugmire (AVCO Corp.) *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 585–632 refs (See N65-12393 03-34)

Frequency-dependent radiant flux density from an infinitely long cylindrical arc column, including self-absorption, was calculated and summarized for pressures up to 300 atm, with the aid of a digital computer, for several measured and assumed temperature profiles. A quasi-optically thin model is accurate up to about 50 atmospheres. At 300 atm, a complete accounting for self-absorption predicts flux densities that are about 60% lower than quasi-thin. Measurements of total radiant flux density that are carried out at 2.0 atm are somewhat lower than the calculations. Author

**N65-12396#** Electro-Optical Systems, Inc., Pasadena, Calif. Plasma Physics Dept.

**THE RADIATING ARC-COLUMN**

G. L. Marlotte, R. L. Harder, and R. W. Prichard *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 633–672 refs (See N65-12393 03-34)

Simple analytic expressions are derived for describing the radiation from an arc confined in a cylindrical constrictor. These

expressions were obtained by postulating linear relations among the plasma properties $\sigma$, u, and $\phi$, the electrical conductivity, the power radiated per unit volume, and the thermal-conductivity integral, $\int_0^T K\,dT$, respectively. The radiation from such arcs in argon and nitrogen was measured as a function of the arc current and of the gas pressure in the confining cylinder. These measurements are compared to the analytical predictions, and the correlation is found to be good, except for the electric-field dependence upon current. The correlation was greatly improved by modifying the results of the analysis to include, in an approximate manner, the nonlinear relations that actually exist among the properties of the plasma. Similarity parameters, which are inferred from the analysis and approximately derived from the basic equations, are applied successfully to the measurements with argon and to extensive calculations with nitrogen. Author

**N65-12397#** Royal Aircraft Establishment, Farnborough (Gt. Brit.)

**EFFECTS OF A RADIATIVE HEAT-SINK ON ARC VOLTAGE-CURRENT CHARACTERISTICS**

W. T. Lord *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 673–708 refs (See N65-12393 03-34)

A simple radiative heat sink is introduced into a well-known theoretical arc model. The arc voltage–current characteristic is expressed in a nondimensional form that shows the importance of the effect of the heat sink. The theory is applied to two types of arc: (1) the wall-stabilized static arc in a circular cylindrical tube of finite radius; and (2) the convection-stabilized arc, held at rest (by means of a suitable magnetic field) against a uniform flow of finite velocity. For the wall-stabilized arc, the effects of radiation are reduced if the pressure is decreased and if the tube radius is decreased. For the convection-stabilized arc, the effects of radiation are reduced if the pressure is increased and if the flow velocity is increased. Numerical examples, based on published experimental results, are given. Author

**N65-12398#** France. Office National d'Etudes et de Recherches Aeronautiques, Chatillon-sous-Bagneux.

**ANALYSIS OF EXPERIMENTAL RESULTS OBTAINED IN AN ARC USING ARGON [ANALYSE DES RESULTATS EXPERIMENTAUX OBTENUS SUR UN ARC A L'ARGON]**

Jean Fabri *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 709–726 refs In FRENCH: ENGLISH summary (See N65-12393 03-34)

In comparing theoretical predictions with experimental results from tests on constricted arcs stabilized by a magnetic field, taking into account real-gas properties causes additional difficulties. The use of argon, a perfect monatomic gas for a wide range of temperatures, makes it possible to achieve a more accurate comparison between experimental data and theoretical results. It also makes it possible to bring out the effects of the main magnetofluid dynamics parameters (gas pressure and output, current, and stabilizing magnetic-field intensities) on the arc rotating speed, the heat transfers to the walls and the efficiency of the system. Author

**N65-12399#** France. Office National d'Etudes et de Recherches Aeronautiques, Chatillon-sous-Bagneux.

**ARC GENERATORS OF WARM GAS [GENERATEURS DE GAZ CHAUDS A ARC]**

Francois Charron *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 727–750 In FRENCH (See N65-12393 03-34)

The development of dc plasma arc heaters at O.N.E.R.A. is described. Heaters equipped with graphite cathodes have operated well in many respects but deliver air with reduced oxygen content due to combustion of the graphite. As a followup to these heaters, two heaters with a cooled metal cathode are being developed. The first, which has been in operation for several months, achieves a power of 280 kW at an efficiency of about 45% for 3 min. safe operating time. The ratio of the weight of metal eroded in 1 sec at the electrodes to the blown air-mass flow rate does not exceed 6 per thousand. These results were obtained through suppression of the effect of the end of the cathode that passes through the heater, and by an increase in the magnetic field. The second heater is designed according to the same concept but with dimensions approximately three times larger to give a terminal power from 1000 to 3000 kW and a generating temperature depending on air-mass flow rate of from 3000° to 4200° K. M.P.G.

**N65-12400#** Minnesota U., Minneapolis. Heat Transfer Lab.

**PERFORMANCE CHARACTERISTICS OF A FULLY-DEVELOPED CONSTRICTED TRANSPIRATION-COOLED ARC**

E. R. G. Eckert and J. E. Anderson *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 751–795 refs (See N65-12393 03-34)

A possible way to increase the peak enthalpy in a gas stream heated by a constricted arc is to make the constrictor wall porous and to inject some of the gas through this wall for cooling. In this paper, the peak enthalpy of such an arc heater is compared with the peak enthalpy obtainable in a heater of identical geometry, but with a water-cooled constrictor wall. The comparison is made on the basis of a model that strongly simplifies the thermodynamic and transport properties of the gas. (Ratio of specific heat to thermal conductivity is constant; electrical conductivity is zero below a certain enthalpy $h_e$ and increases linearly with the enthalpy above, radiative power emitted per unit volume is zero below $h_e$ and constant above.) The results indicate that the peak enthalpy at the center line of the exit cross section of the transpiration-cooled constrictor can attain values more than an order of magnitude higher than in a water-cooled constrictor. Author

**N65-12402#** General Electric Co., King of Prussia, Pa. Space Sciences Lab.

**GROWTH OF AN ARC COLUMN IN FLOW AND PRESSURE FIELDS**

H. E. Weber *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 845-881 refs (See N65-12393 03-34)

A study is presented of the behavior of an arc discharge in coaxial gas flow downstream of the cathode in a tube. Energy from the discharge diffuses radially outward into the flowing gas. The arc column grows to the tube radius some distance downstream of the cathode. This distance is directly proportional to mass velocity for a given current. At given axial distance and mass velocity the column radius increases with current. After the arc column has grown to the tube radius, both enthalpy and velocity profiles become fully developed. From solution of the energy equation and Ohm's law in fully developed flow, a map of arc characteristics is made relating voltage gradient, current, centerline enthalpy, and column radius. The assumption is made that the column growth is sufficiently small so that the local column behavior is the same as a column in fully developed flow carrying the same current at the local column radius. Predictions from the theoretical model are consistent with physical observations. Correlations are good between theoretical and experimental enthalpy profiles and voltage–current characteristics. Author

**N65-12404#** Deutsche Versuchsanstalt für Luft- und Raumfahrt, Stuttgart (W. Germany). Institut fur Plasmadynamik
**MOTION OF THE PLASMA COLUMN IN THE INTERIOR AND AT THE EXIT OF AN ARC JET**
Gerhard Kruelle *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 903–934 refs (See N65-12393 03-34)

In order to explain pulsations observed in the operation of arc-jet engines, the transient behavior of the plasma column in the interior and at the exit of such an engine has been studied, by use of a Fastax high-speed camera. In addition, the transient arc voltage was recorded. Argon, nitrogen, helium, and hydrogen were used as propulsion gases. The results are explained and discussed in detail. Three different modes of discharge exist: the stationary discharge with a diffused arc terminus at the anode, the stationary discharge with a discrete fluctuating terminus, and the quasi-stationary discharge with current transport by many small discrete arc threads. With argon, all modes of discharge were realized, the stationary mode corresponding to an increased mean power. In principle, helium showed a similar behavior, whereas the two molecular gases were seen to incline to the quasi-stationary mode. The type of flow—whether laminar or turbulent—in the throat region was found to be a criterion for the mode of discharge. Author

**N65-12405#** Michigan U., Ann Arbor.
**SOME OBSERVATIONS OF AN ELECTRIC ARC MAGNETICALLY CONFINED IN A TRANSVERSE SUPERSONIC FLOW**
Charles E. Bond and Arnold M. Kuethe *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 935–979 refs (See N65-12393 03-34)

A method has been developed for the magnetic stabilization of a dc electric arc in a supersonic airflow. Observations are presented of the behavior of the stabilized arc, including the observation that the positive column of the stable supersonic arc is slanted with respect to the electric field. The experimental setup consists of two rail electrodes mounted in a supersonic wind tunnel. Stability is provided by an external magnetic field that is mutually perpendicular to the electric field and to the free stream. The magnetic flux density increases in the downstream direction. At Mach 2.5, only one angle-of-slant is observed, independent of arc current, free-stream pressure, and interelectrode gap. The angle-of-slant is near that of a free-stream Mach line at Mach numbers 2.0 and 2.5. The direction of slant is the Hall direction, but the angle-of-slant does not appear to vary with the Hall parameter $\omega_e\tau_e$. Author

**N65-12407#** Illinois U., Urbana.
**BOUNDARY LAYER MOTION IN A TWO-DIMENSIONAL ARC-HEATED CHANNEL**
S. L. Soo and M. N. Bahadori *In* AGARD Arc Heaters and MHD Accelerators for Aerodyn. Purposes, Pt. 2 Sep. 1964 p 1013–1051 refs (See N65-12393 03-34)

Laminar boundary-layer motion of partially ionized argon was studied using a steady flow two-dimensional arc-heated channel that is capable of precise computations. Study consists of extension of boundary-layer theory to the case of flow of an ionized gas over a cooled wall. Evaluation of experimental results shows the nature of relaxation of electron states within the boundary-layer thickness, and gives transport properties of a nonequilibrium ionized gas. Results show that, when applied to the condition at reentry, substantial electrical and thermal conductivity not too much lower than those of the ionized gas behind the shock wave exists at a cooled wall, although the gas temperature decreases significantly toward the wall. Author

**N65-12454#** Princeton U., N.J. Plasma Physics Lab.
**A MULTIPLE BOUNCE THEORY FOR THE EXPANSION AND RETARDATION OF A COLD PLASMA EXPLOSION BUBBLE**
M. D. Kruskal, I. B. Bernstein, and R. M. Kulsrud Aug. 1964 34 p
(Contract AT(30-1)-1238)
(MATT-271)

The motion, consisting primarily of free expansion but also of the beginning of retardation, of a mainly spherical bubble of cold plasma is analyzed by considering the multiple collisions of its elements with the interface separating it from the external ambient medium, which is not itself analyzed but merely treated as exerting a known pressure on the bubble. The thickness of the layer of material that has already collided is computed, and an appropriate and simple "snowplow approximation" is provided for the case that this thickness may be considered small, which is so for most purposes. In dimensionless units chosen to make the plasma mass and its initial radial velocity both unity and the external pressure $1/4\pi$, the behavior of the bubble radius for short times is given by

$$R(t) = t - at^{5/2} + \ldots$$

where $a = 0.2225$ for the multiple bounce treatment and is 6% larger for the snowplow approximation. The thickness of the layer is 1/7 of the "lag" ($at^{5/2}$) of the bubble behind free expansion. Author

**N65-12480#** Hughes Research Labs., Malibu, Calif.
**CESIUM PLASMA STUDIES FOR THERMIONIC ENERGY CONVERSION, PHASE II Final Report**
J. Y. Wada and R. C. Knechtli Jun. 1963 80 p refs
(Contract Nonr-3501(00))
(AD-408915)

Research in thermionic energy conversion in relation to the fundamental properties of plasmas was performed by the following three studies: (1) the thermalization of fast electrons injected into a highly ionized plasma; (2) the resistivity of a highly ionized plasma; and (3) the probability of neutralization of cesium ions on a hot tantalum surface. G.G.

**N65-12576#** Northwestern U., Evanston, Ill. Gas Dynamics Lab.
**AN EXPERIMENTAL STUDY OF RADIANT ENERGY TRANSFER FROM A PLASMA**
James M. Berry and Richard S. Tankin Arnold AF Sta., Tenn., Arnold Eng. Develop. Center, Nov. 1964 140 p refs
(Contract AF 40(600)-972)
(AEDC-TDR-64-233; AD-451409)

A thermistor bolometer was used to determine the radiant-energy transfer from a typical laboratory plasma. Radiation was found to be a significant mechanism of energy transfer from an atmospheric argon plasma jet, amounting to as much as 18% of the net power input to the plasma. The radiant-energy transfer from an atmospheric nitrogen plasma jet under comparable conditions was found to be less than 1% of the net power input to the plasma. The radiative power density in an atmospheric argon plasma was determined. Contributions from both bremsstrahlung and recombination radiation were found to be important. A model, based on the Kramers and the Unsöld approximations, was used to predict the radiative power density in an atmospheric argon plasma. Author

**N65-12742#** General Motors Corp., Santa Barbara, Calif. Defense Research Labs.

**ELECTROMAGNETIC WAVE REFLECTION FROM A METAL-BACKED NON-UNIFORM PLASMA LAYER FOR NON-NORMAL INCIDENCE**

Henry M. Musal, Jr. Aug. 1964 15 p refs

(Contract DA-04-495-ORD-3567(Z); ARPA Order 357-63; Proj. Defender)

(CTN64-06; AD-449859)

This study presents a technique for the calculation of the reflection coefficient for a plane, transverse, electromagnetic wave incident nonnormally on a nonuniform plasma layer with a metal-backed wall. An arbitrarily polarized incident electromagnetic wave is considered that is composed of transverse electric and transverse magnetic modes. The reflection coefficient for each of these different modes is then found separately through the solution of a pair of second-order linear differential equations, with given initial conditions at the metal wall, over the interval defined by the thickness of the plasma layer. G.G.

**N65-12743#** General Motors Corp., Santa Barbara, Calif. Defense Research Labs.

**A NUMERICAL INVESTIGATION OF THE VALIDITY OF THE BORN APPROXIMATION FOR DETERMINATION OF THE REFLECTION COEFFICIENTS OF UNDERDENSE PLASMA SLABS**

S. Zivanovic Oct. 1964 22 p refs

(Contract DA-04-495-ORD-3567(Z); ARPA Order 357-63; Proj. Defender)

(CTN64-08; AD-450205)

The validity of the Born approximation for determination of the reflection coefficients of plasma slabs is numerically examined for the following two cases: (1) the uniform underdense plasma slab; and (2) a plasma slab with a sinusoidal electron-density perturbation superimposed on a constant electron density. The regions of validity of the Born approximation are discussed in each case. Author

**N65-12764#** Princeton U., N.J. Plasma Physics Lab.

**THEORETICAL FINE STRUCTURE OF He II 4686 Å IN MAGNETIC FIELDS TO 40 KILOGAUSS**

P. C. Norem Jun. 1964 43 p refs

(Contract AT(30-1)-1238)

(MATT-280)

The wavelengths and intensities of the 146 fine structure components of the 4686 A-line of ionized helium have been determined in vacuum for magnetic fields up to 40 kG. The line is treated as a group of doublet transitions with observed positions and separations. The wavelengths of these components are determined by more or less conventional methods, and the intensities by solving general equations for the specific component and magnetic field of interest. The F and D components, which give the dominant contribution to the total intensity, exhibit an almost complete Pashen–Back effect above 20 kG. A statistical population of the n = 4 level is assumed. Author

**N65-12780#** Polytechnic Inst. of Brooklyn, N.Y.

**HALL CURRENT PLASMA ACCELERATOR WITH COUPLED NON-EQUILIBRIUM IONIZATION AT ELEVATED ELECTRON TEMPERATURES. PART I: THEORY AND GOVERNING EQUATIONS**

Martin I. Hoffert Oct. 1964 31 p refs

(PIBAL-860)

This report presents an analytical framework for the investigation of MGD acceleration by induced Hall currents. Numerical results will be given in subsequent reports and utilized to design the experimental phase of this research. Since the mechanism of $j_\theta B_r$ accelerating forces has been established experimentally using high-temperature arc jets as the plasma source, emphasis is placed on relatively cool working fluids where nonequilibrium ionization due to elevated electron temperatures may be a factor. The analytical model of Kerrebrock for this process is incorporated in the analysis. Author

**N65-12821#** Republic Aviation Corp., Farmingdale, N.Y. Power Conversion Systems Div.

**SIMULATION AND PROTOTYPE CONSTRUCTION, PROJECT CANTALOUPE Final Report**

L. Kraus Kirtland AFB, N. Mex., Res. and Technol. Div., Aug. 1964 89 p refs

(Contract AF 29(601)-2866)

(RTD-TDR-63-3097; AD-606249) OTS: $4.00

A theta-pinch apparatus that was specifically designed for the purpose was used to study Rayleigh–Taylor instabilities at a plasma–magnetic-field interface. Special features include preionization, a pulse-shaping network, and a provision for transverse as well as axial photography. A constant magnetic field results in a constant velocity radial compression, in good agreement with "snowplow" theory. In this case, as expected, no surface instabilities are observed. A sinusoidal compression field, however, results in instabilities whose wavelength and growth rate are measured. Theoretical dispersion relations for finite electrical conductivity and for finite viscosity are derived. In addition, the mode of maximum instability is determined. These relations are compared with the experimental results. Author

**N65-12824#** Microwave Associates, Inc., Burlington, Mass.

**APPLIED RESEARCH ON METHODS OF COUPLING TO ELECTROMAGNETIC WAVES IN PLASMA AMPLIFIERS Final Report**

K. K. Chow Wright-Patterson AFB, Ohio, AF Avionics Lab., 6 Oct. 1964 96 p refs

(Contract AF 33(657)-8984)

(AL-TDR-64-150; AD-606977) OTS: $4.00

This report contains the findings of the feasibility study of directly coupling microwave power to beam–plasma interaction systems without the use of slow wave circuits. Direct coupling is an essential step toward fully utilizing the advantages of beam–plasma interaction, since conventional slow wave couplers restrict the power handling capabilities and the ease of device fabrication. Theoretical work performed indicates that such coupling is possible by using a long modulation space fed by smooth waveguide. Experimental data give qualitative demonstration of this coupling. Further investigation is recommended, and other approaches are discussed. Author

**N65-12851#** Douglas Aircraft Co., Inc., Long Beach, Calif. Aircraft Div.

**SOLUTIONS OF THE MAGNETOFLUID-DYNAMIC BOUNDARY-LAYER EQUATIONS FOR A FLAT PLATE WITH A MOVING TRANSVERSE MAGNETIC FIELD SOURCE OR CROSSED ELECTRIC FIELD IN THE SPANWISE DIRECTION**

N. A. Jaffe 1 Nov. 1964 51 p refs

(LB-31693)

The effects of a transverse magnetic field on velocity profiles in the boundary layer of a conducting fluid are investigated. A numerical technique is used to obtain solutions of the combination of continuity and momentum equations for flow of an incompressible fluid over a flat plate. Variable conductivity and constant conductivity are studied. In the former case a magnetic-field velocity ratio is defined, and its effect on velocity profiles is examined. This parameter arises either from a source of the magnetic field moving with respect to the surface or from an applied electric field parallel to the surface in the spanwise direction. Velocity profiles and corresponding skin friction, net drag, displacement thickness, and momentum thickness are given for magnetic-interaction parameters over a range from 0 to 0.6 and magnetic-field velocity ratios ranging from 0 to 50. Nonsimilarity effects are studied by solving the equations when the magnetic-interaction parameter is allowed to increase linearly with distance from the leading edge.
Author

**N65-12884#** Microwave Associates, Inc., Burlington, Mass.
**APPLIED RESEARCH ON COUPLING SCHEMES FOR PLASMA AMPLIFIERS Interim Engineering Report, 1 Apr.–30 Jun. 1964**
Paul Chorney [1964] 47 p refs
(Contract AF 33(615)-1110)
(IER-3; AD-450174)

A scattering-matrix representation of the 4-port study vehicle is presented in a theory, and quantities are introduced that express coupling losses and coupling enhancement due to plasma. Experiments on a coupling study vehicle are described in which coupling enhancements as high as 13 dB were observed from the output plasma coupler. The input plasma coupler showed a negative enhancement that is attributed to nonlinearities in the beam-plasma interaction and to asymmetries in the plasma. The design of a second study vehicle is described, which is based on the observations in the coupling experiments. A transition from rectangular waveguide to parallel-plate waveguide has been constructed for an elliptical feed system; the experimental model and the results of some tests are described.
Author

**N65-12886#** Microwave Associates, Inc., Burlington, Mass.
**INVESTIGATION OF HIGH POWER GASEOUS ELECTRONICS Seventh Quarterly Progress Report, 16 May–15 Aug. 1964**
H. S. Maddix and J. Gregory [1964] 27 p refs
(Contract DA-36-039-AMC-00097(E))
(Rept.-7; AD-450108)

The use of thin metallic films to control gas cleanup in quartz vials was further investigated. One to two orders of magnitude reduction in square root cleanup rate can be realized by using a thin tungsten film as a diffusion barrier. Barrier life of up to 150 operating hours was achieved by protecting the metal barrier with a surface layer of tungsten oxide or silicon dioxide. The sorption of argon in OFHC copper was observed to occur at higher rates than anticipated. An activation energy of 5.05 kcal/mole for the sorption of argon by OFHC copper was determined from preliminary sorption data. The square root sorption rate of argon in quartz was observed to vary linearly with the square root of peak incident power at constant pulse repetition rate. The square root sorption rate of argon and neon in quartz appears to be only weakly dependent on average power or pulse repetition rate over a 40- to 200-kc range.
Author

**N65-12893#** Polytechnic Inst. of Brooklyn, N.Y. Microwave Research Inst.
**STUDIES IN MICROWAVE PHYSICS Final Report**
Herman Farber and Leo M. Silber Sep. 1964 45 p refs
(Contract Nonr-839(35))
(PIBMRI-1241-64; AD-450015)

Studies on the breakdown strength of high-pressure gases at microwave frequencies and on the interaction of high microwave powers with plasmas were initiated. Design of suitable microwave cavities is discussed, and construction details are presented. The breakdown measurement studies demonstrated that a cylindrical waveguide transmitting in the $TE_{01}$ mode has a higher power capacity than the reported computed values. The design data for the cavity, to be used in the plasma studies, indicate that 80% or more of the power into the cavity may be coupled to the plasma if it has a sufficiently high conductivity. Preliminary measurements and complete construction details are presented.
Author

**N65-12907#** Utah U., Salt Lake City. Upper Air Research Lab.
**A PLASMA RESONANCE AND ELECTRON TEMPERATURE EXPERIMENT Scientific Report No. 3**
Alvin M. Despain 3 Aug. 1964 91 p refs
(Contracts AF 19(628)-447; DASA-WEB-07.007)
(AFCRL-64-809; AD-608494)

This report discusses some plasma and ionosphere parameters, investigates some appropriate measurement techniques, considers the design of a rocketborne experiment to measure plasma resonance and electron temperature, and presents some preliminary flight results. Two parameters of special interest are electron density, characterized by the plasma frequency, and electron temperature. A rocketborne experiment that measures the electrical characteristics of a probe or antenna can yield these important ionospheric parameters. Such an experiment was designed to measure the dc volt–ampere characteristics of a rocketborne rf excited probe. The flight results showed the expected plasma resonance clearly evident in addition to other, unexpected, phenomena. Preliminary data analysis produced measurements of electron temperature that compare reasonably well with the expected values.
Author

**N65-12924#** AVCO Corp., Wilmington, Mass. Research and Advanced Development Div.
**ELECTROMAGNETIC ABSORPTION EFFECTS IN PLASMA SPHERES Final Report**
N. E. Pedersen and J. Davis 25 Nov. 1964 63 p refs
(Contract AF 19(628)-3309)
(AFCRL-64-805; RAD-TR-64-37; AD-608521)

A set of equations are developed describing the steady-state thermodynamics of a homogeneous plasma sphere for electromagnetic plane-wave absorption in the case of electric-dipole absorption resonance. The thermodynamic properties of the system are obtained by coupling a modified Saha equation with the electromagnetic resonance conditions for maximum power absorption. The main results of this analysis are graphically illustrated for the case of a partially ionized argon plasma. Also included are regions of validity for which such a system is compatible with the electromagnetic resonance conditions, as well as with the fundamental limitations imposed by the physics of the problem. In fact, it is shown that the plasma sphere radius is restricted to values less than 5 cm (order of magnitude) and an incident angular frequency of greater than $10^{10}$ $sec^{-1}$. The gas temperature increases as frequency increases, and the radius decreases with increasing frequency.
Author

**N65-12928#** General Electric Co., Philadelphia, Pa.
**VOLTAGE DISTRIBUTION, IONIZATION, AND ENERGY BALANCE IN THE CATHODE REGION OF AN ARC**
T. H. Lee, Allan Greenwood, W. D. Breingan, and H. P. Fullerton
Wright-Patterson AFB, Ohio, ARL, Oct. 1964 82 p refs
(Contract AF 33(657)-8206)
(ARL-64-152; AD-608937)

Formulations are given for the several subregions of a model for the cathode region of an argon arc. It is shown that it is necessary to include a new transition region in which the ordinary transport theory cannot be applied. Limiting characteristics for this new region are worked out. Numerical results are obtained for that part of the arc between the cathode and the contraction region. These are presented in the form of profiles of voltage, particle concentration, and temperature. The computer program for the contraction region is described in detail. It is demonstrated that the cathode drop is about six or seven volts, which accords with experimental observation. This does not all appear across a positive-ion space-charge sheath, but includes adjacent parts of the discharge including the ionization region. It is further shown that it is possible to produce the necessary ionization to support the arc although the ionization potential of the gas greatly exceeds the cathode drop. Author

**N65-13001#** Microwave Associates, Inc., Burlington, Mass.
**MILLIMETER WAVE COMPONENT DEVELOPMENT (BEAM-PLASMA AMPLIFIER) Fifth Technical Note**
Paul Chorney and Richard J. Madore Griffiss AFB, N.Y., RADC, Oct. 1964 44 p refs
(Contract AF 30(602)-2948)
(RADC-TDR-64-354; AD-608616)

Experiments are described on a plasma tester that allows radial and axial density profile measurements to be taken. A definite density maximum in the radial profile is shown that was not observed in previous experiments. The axial profiles show a maximum in the center of the discharge. Data were taken with pressure and magnetic field as parameters. A new Langmuir probe design is discussed in which the probe is shielded from cathode evaporation and sputtering. A theory for the double-hot-cathode PIG discharge is described based on ambipolar diffusion in a magnetic field. The theory indicates density profiles that are in agreement with experiments. Thus it is concluded that the discharges are diffusion controlled. The present status of the 2-mm BPA study vehicle is described. The results of electrical measurements on some of the waveguide components are discussed. Author

**N65-13025#** Princeton U., N.J. Gas Dynamics Lab.
**ON THE INTERACTIONS OF A SOLID BODY WITH A FLOWING COLLISIONLESS PLASMA**
S. H. Lam and M. Greenblatt Jul. 1964 41 p refs Presented at the 4th Intern. Symp. on Rarefied Gas Dyn., Toronto, Jul. 1964 *Its* Rept.-699
(Contract AF 49(638)-1271)
(AFOSR-64-1421; AD-608545)

A class of satellite–ionosphere interaction problems is considered under the basic framework of a collisionless plasma flow and a body surface that is perfectly absorbing. Attention is confined to the case of a negatively charged body, and it is further assumed that the electron temperature is much larger than the ion temperature. Taking full advantage of the fact that the Debye-length is small compared to the body dimension, the disturbances are divided into a quasi-neutral region and a sheath layer. In the analysis of the quasi-neutral region, it is shown that both the ion and the electron flow fields are irrotational, and under certain conditions the two flow fields can be mathematically uncoupled. The structure of the sheath layer is analyzed, and Bohm's sheath criterion is recovered. The matching of the quasi-neutral solution to the sheath solution is discussed, and illustrative solutions for a wedge, a cone, and a sphere are presented. D.S.G.

**N65-13157#** Westinghouse Electric Corp., Pittsburgh, Pa. Research and Development Center
**LONG LIFE CLOSED LOOP MHD RESEARCH AND DEVELOPMENT UNIT Quarterly Technical Progress Report, 1 Jun.–31 Aug. 1964**
R. L. Hundstad, F. A. Holmes, and M. G. Fey Wright-Patterson AFB, Ohio, AF Aero Propulsion Lab., 31 Aug. 1964 20 p
(Contract AF 33(657)-8311)
(QTPR-10; AD-605365)

The results of the third test of the Closed Loop MHD Research and Development Unit are presented and compared to previous results. The goal of 1 mho/m for the gas conductivity in the generator was met and exceeded during the warmup phase of the test. This conductivity is consistent with theoretical data for a temperature of 1860° K, which was measured near the generator inlet. During this test, the plasma temperature was 530° K higher than that attained in previous tests. Although the test did not go beyond the warmup phase because of a malfunction of one of the heater power leads, the temperature achieved indicates that thermal insulation problems with previous end return designs have been solved, and that generator output can be inferred from comparison with previous data. D.S.G.

# 26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

**N65-12361#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INVESTIGATION OF ERRORS OF APPROXIMATE FORMULAS FOR CALCULATION OF DIELECTRIC CONSTANT, BY MEASURED RESONANCE METHOD**
O. V. Stoyakin *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 103–112 refs (See N65-12351 03-34)

The resonance method for the measurement of dielectric constants is based on measurement of the shortening of the resonance length of a tuned coaxial line that results from the introduction of a sample of the dielectric into the tuned coaxial line. Two approximate formulas for determining the dielectric constant when using the resonance method are discussed, and the systematic errors obtained during their use are outlined. P.V.E.

**N65-12362#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**QUESTION OF MEASUREMENT OF PARAMETERS OF MAGNETODIELECTRICS IN DECIMETRIC WAVE RANGE**
I. A. Gilinskiy and A. F. Kugayevskiy *In its* Invest. in the Field of Radiotech. Meas. 15 Sep. 1964 p 113–119 (See N65-12351 03-34)

The measurement of magnetodielectric parameters using a coaxial resonator is considered. Both the no-load method and the short circuit method are included. It is shown that with these methods the dielectric constant and the magnetic permeability can be determined separately. P.V.E.

**N65-12410*#** Space Technology Labs., Inc., Redondo Beach, Calif.
**CHARGED PARTICLE RADIATION DAMAGE IN SEMICONDUCTORS, X: THE ENERGY DEPENDENCE OF ELECTRON DAMAGE IN SILICON**
3 Sep. 1964 43 p refs
(Contract NAS5-3805)
(NASA-CR-59669; STL-4161-6004-KU-000) OTS Prices: HC $2.00/MF $0.50

An energy dependence function over the range 0.4 to 40.0 MeV was determined, permitting estimation of solar-cell-radiation damage and subsequent power-supply degradation in space for n on p cells of any resistivity to an accuracy better than the knowledge of the radiation environment in space. The shape of the energy-dependence curve of electron-radiation damage in p-type silicon is independent of resistivity and, therefore, the difference in absolute damage rates for any energy can be predicted over the range of resistivities from 1.0 to 21.0 ohm cm. The energy levels and defect mechanisms responsible for electron-radiation damage in silicon were investigated and are discussed in detail. D.S.G.

**N65-12453#** National Bureau of Standards, Washington, D.C.
**RESEARCH ON CRYSTAL GROWTH AND CHARACTERIZATION AT THE NATIONAL BUREAU OF STANDARDS DURING THE PERIOD JANUARY TO JUNE 1963**
H. Steffen Peiser, ed. 23 Sep. 1963 48 p refs
(NBS-TN-197) GPO: $0.30

The National Bureau of Standards with partial support from the Advanced Research Projects Agency is continuing diverse research projects on the growth and characterization of crystals. This note summarizes the individual NBS activities in this and closely related fields during January to July 1963. Lists of NBS publications appertaining to that period and of participating NBS scientists are appended. Author

**N65-12460#** Maryland U., College Park.
**MATERIALS SCIENCE PROGRAM Technical Report, 1 Jul. 1963–30 Jun. 1964**
Richard A. Ferrell et al [1964] 113 p refs
(ARPA-SD-101)

This report contains a review of research pertaining to experimental and theoretical physics, chemistry, molecular physics, and mechanical engineering. Brief resumés are given of each study, and the obtained results are presented in short forms. G.G.

**N65-12494** Honeywell, Hopkins, Minn. Research Center
**PLASTIC DEFORMATION OF CALCIUM TUNGSTATE SINGLE CRYSTALS Technical Report No. 26**
A. Arbel and R. J. Stokes Jul. 1964 20 p refs
(Contract Nonr-4076(00))
(HR-64-275; AD-604183)

Calcium tungstate deforms by slip on the (001) <100> system above 400° C. Simple shear over this plane is the only deformation mode observed under compression at temperatures up to 900° C and at a strain rate of $10^{-3}$ $sec^{-1}$. The critical resolved shear stress is strongly temperature dependent. Crystals cannot be plastically deformed at room temperature; at 400° C they are still quite brittle, but by 900° C they are soft (yield stress, 500 psi) and plastic. Slip traces at all temperatures are fine and straight but those produced at lower temperatures (600° to 700° C) have a greater surface tilt and are more sharply defined than those produced above 800° C. The role of bonding and crystal structure in the selection of slip parameters is discussed. It is considered that the stacking of the oxygen ions is the dominant factor dictating the slip plane and slip direction. Slip cannot occur without some distortion of the covalently bonded $WO_4^{--}$ radical. Author

**N65-12495#** California U., Riverside.
**ENERGY OF ELECTRONS EXTRACTED FROM SOLIDS BY HIGH ELECTRIC FIELDS Final Report, Jun. 1959–Sep. 1964**
Allan M. Russell [1964] 33 p refs
(Contract Nonr-1842(02))
(AD-606407)

This study contains the history and a summary of the progress made in field-emission spectroscopy and related research. The development of a field-emission spectrometer consisting of an experimental field-emission tube and an associated vacuum system with a detection system is presented. The application of this spectrometer in the measurement of the energy spectra of electrons from the sample emitter during use in high elastic fields is described. Also presented are two methods of obtaining sufficiently large electron fields for electron tunneling on the surface of solids. G.G.

**N65-12518#** Naval Ordnance Lab., Corona, Calif. Research Dept.
**PROPERTIES OF PHOTODETECTORS**
W. L. Eisenman, A. B. Naugle, and J. D. Merriam 1 Oct. 1964 25 p *Its* Photodetector Ser. 63rd Rept.
(NOLC-609; AD-451759)

Results of measurements made on eight photodetectors are presented. Included are data sheets on four silicon cells, one indium arsenide cell, and three lead sulfide cells. Author

**N65-12585#** Honeywell, Hopkins, Minn. Honeywell Research Center
**THE MECHANICAL AND MICROMECHANICAL PROPERTIES OF BORON Interim Report No. IV, 1 Jul.–31 Aug. 1964**
J. A. Sartell and C. J. Speerschneider 15 Sep. 1964 17 p refs
(Contract NOw-64-0159-f)
(HR-64-281; AD-447656)

The modulus of elasticity of crystalline ($\beta$-rhombohedral) boron was determined by using a dynamic technique. Microstrain measurements utilizing a Tuckerman optical strain gage and a compression testing procedure were initiated on cast boron. Author

**N65-12593#** Naval Research Lab., Washington, D.C. Electronics Div.
**SIMULTANEOUS CONTAMINATION AND CONVERSION EFFECTS IN GERMANIUM HEATED TO TEMPERATURES IN THE EVAPORATION RANGE**
John E. Davey and M. D. Montgomery 26 Jul. 1963 8 p refs
(NRL-5965; AD-419577) OTS: $1.00

Studies of germanium source material used for the vacuum evaporation of thin germanium films have been carried out by

measuring the changes in the electrical properties of sources heated in the temperature range from 1100° to 1600°C. Using standard evaporation techniques and standard boat materials, the source germanium converts strongly to p-type, regardless of initial conductivity or type, and the properties of the resulting films are insensitive to the properties of the source. In a study of the causes of this source conversion, a number of experiments were performed that involved simple evaporation and combined zone-refining and evaporation processes in quartz and graphite boats in vacuum and helium ambients. The results indicate that the prevention of source conversion in vacuum may be attained by utilization of the zone-refining process in graphite, in situ, prior to treatment of the germanium as an evaporant. Author

**N65-12645#** United Kingdom Atomic Energy Authority, Harwell (Gt. Brit.) Engineering Div.
**A SUPERCONDUCTING TRANSFORMER AND CHARGING CIRCUIT FOR A HIGH FIELD MAGNET**
D. A. Watt London, HMSO, Jul. 1964 13 p
(AERE-M-1397) HMSO: 2s 6d

This report details the principle of operation of a superconducting transformer and charging circuit for building up very large superconducting circulating currents in a magnet winding operated under liquid helium. Supporting experimental tests are covered. Author

**N65-12727*#** Brown U., Providence, R.I.
**EXPERIMENTAL INVESTIGATIONS IN EPITAXIAL GROWTH OF CRYSTALLINE LAYERS Final Report**
H. E. Farnsworth and C. A. Haque 31 Oct. 1964 13 p refs
(Grant NsG-418)
(NASA-CR-54206) OTS Prices: HC $1.00/MF $0.50

Nickel is evaporated in high vacuum from a calibrated source, one monolayer at a time, on a clean (111) copper single-crystal substrate. Excellent order in arrangement of condensed nickel atoms with the same orientation as the substrate, but with the lattice spacing of nickel, is observed when the substrate is maintained at about 200° C during evaporation. Each successive monolayer grows epitaxially with respect to the layer immediately below it, always with the lattice spacing of nickel. No more than three atomic layers contribute appreciably to the diffracted intensity below about 250eV. The contribution from the first layer predominates. Author

**N65-12753#** Arizona State U., Tempe.
**OXIDE SEMICONDUCTOR MATERIALS AND DEVICE RESEARCH Quarterly Progress Report, 18 May–17 Aug. 1964**
F. L. English, C. J. Kevane, J. J. Morrison, B. M. Warmkessel, and H. B. Whitehurst [1964] 18 p refs
(Contract DA-36-039-SC-89151)
(QPR-11; AD-451744)

An empirical equation has been developed to describe the resistance of semiconducting rutile as a function of time during approach to equilibrium after a sample has been heated and cooled rapidly. Three constants are involved in the equation; two represent the equilibium resistance of the sample and the initial value of the resistance; the third is characteristic of the individual sample and its temperature and has the dimensions of time. The equation may be derived from kinetic theory if the rate of change of the resistance is assumed to be proportional to the square of a quantity representing the difference between the equilibrium value for the number of current carriers and the value at the time of observation. The equation may be rearranged into a linear form for the determination of the constants. Additional studies have been made of the effect of surface treatment on the time-dependent resistivity. The results indicate that the phenomeon does not depend primarily on surface conditions. Author

**N65-12755#** Melpar, Inc., Falls Church, Va.
**RESEARCH ON ANISOTROPY IN POLYCRYSTALLINE DIELECTRIC MATERIALS Final Report**
21 Jul. 1964 68 p
(Contract NOw-63-0718-f)
(AD-452075)

This report discusses the investigation of the dielectric anisotropy of polycrystalline ceramic materials. Experimental evidence was obtained that showed the presence of both preferred orientation of the individual crystallites and internal stress when dielectric anisotropy was observed in aluminum oxide. The general trend of the degree of preferred orientation, as a consequence of forming method, was also established. Author

**N65-12774#** Stanford U., Calif. Microwave Lab.
**NONLINEAR INTERACTIONS BETWEEN RADIATION AND SYSTEMS WITH QUANTIZED ENERGY LEVELS Final Report, 15 Mar. 1962–15 Mar. 1964**
R. H. Pantell Jul. 1964 69 p refs
(NSF G-22929)
(ML-1194)

Experiments were performed using the photoconductive effect in bulk semiconductors to produce a microwave beat frequency from two axial-mode laser frequencies. A specialized photoconductive frequency mixer, analyzed in terms of its parametric conductances, was developed. Noise calculations indicated that this bulk semiconductor is theoretically quite competitive with the PIN photodiode. G.G.

**N65-12778#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering
**EXPERIMENTAL INVESTIGATION OF CURRENT LIMITING AND OSCILLATION IN CdS**
David R. Garner and Quentin A. Kuttenkuler (M.S. Thesis) Aug. 1964 63 p refs
(GE-EE-64-9; AD-607035) OTS: $3.00

The current limiting and oscillations that occur when low-resistivity CdS is subjected to high-level voltage pulses are experimentally investigated, and several theories are proposed to explain the phenomena. The manufacture of the test samples and the design of a pulse generator utilizing a lumped element delay line and a silicon controlled rectifier are described. From the experimental results, a dependence of the frequency and amplitude of the oscillations on the applied voltage is shown. The theory that best explains the phenomena is found to be the transfer of electronic momentum. Author

**N65-12792#** International Business Machines Corp., Yorktown Heights, N.Y. IBM Watson Research Center
**SELF-COMPENSATION LIMITED CONDUCTIVITY IN BINARY SEMICONDUCTORS II: n-ZnTe**
R. S. Title, G. Mandel, and F. F. Morehead 5 Mar. 1964 15 p refs Part of Proj. Defender under joint sponsorship of ARPA, ONR, and DOD
(IBM-RC-1136)

Paramagnetic resonance has been observed in Al-doped ZnTe grown in excess Te vapor. The resonance is due to a

hole trapped at a defect consisting of a doubly negatively charged zinc vacancy $V_{Zn}^{2-}$ and an $Al^{3+}$ donor ion on one of the 12 zinc sites nearest the $V_{Zn}^{2-}$ The hole is trapped at the defect after irradiating the sample at 77° K with light of energy less than that of the band gap. The g tensor is orthorhombic as expected for such a defect. Compensation of donor or acceptor impurities by doubly, as opposed to singly, ionizable defects has been shown to be important in II-VI compounds. The observed resonance shows that compensation of Al donors in ZnTe by doubly charged zinc vacancies does indeed occur. A consequence of the self-compensation of donor impurities in ZnTe is that there is a limit to how n-type the material can be made. Similar attempts to dope ZnTe n-type were carried out with Ga, In, Br, and I. Author

**N65-12837*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**ORGANIC SEMICONDUCTORS. II: PROPERTIES, SYNTHESIS, AND APPLICATION**
Dorothy I. Sweitzer, comp. 1964 321 p refs
(Contract NAS7-100)
(NASA-CR-59799; JPL/AI/LS-482) OTS Prices: HC $7.00/MF $1.75

Presented is an annotated bibliography on organic semiconductors. The bibliography is divided into four main subject areas: conductivity and semiconductivity, photoconductivity, excited states, and dielectric effects. Entries under each of the four main headings are grouped as follows: general references, theory, experiment, synthesis, and application. P.V.E.

**N65-12909#** University Coll., Cardiff (Gt. Brit.)
**THEORY OF THE DECAY OF EXCESS CARRIER CONCENTRATIONS IN SEMICONDUCTORS Scientific Report No. 2**
D. A. Evans and P. T. Landsberg 1 Jul. 1964 44 p refs
(Contract AF 61(052)-664)
(AFCRL-64-828; AD-608454)

Differential equations are presented for the decay of excess carrier concentrations in semiconductors by Shockley-Read and Auger processes involving recombination centers. An exact solution is obtained for the interaction of centers with the conduction band only, and an approximate solution for the interaction with both bands. For the one-band case, three ranges of excess concentration can be distinguished, in one of which the decay is exponential. For the two-band case, there are four ranges, in three of which the decay is exponential. The theory applies also in the presence of a constant electric field. For small departures from equilibrium the results agree with those derived earlier by a different method. Author

**N65-12912#** Radio Corp. of America, Princeton, N.J. RCA Labs.
**INVESTIGATION OF TWO-CARRIER INJECTION ELECTROLUMINESCENCE Scientific Report No. 2**
A. G. Fischer, J. N. Carides, J. Dresner, W. H. Fonger, G. J. Goldsmith et al 15 Oct. 1964 73 p refs
(Contract AF 19(628)-3866)
(AFCRL-64-858; AD-608491)

Intense-yellow injection electroluminescence starting at 1.35 volts has been discovered and studied in physical inversion layers of metal-semiconductor contacts between high-work-function metals and n-type ZnSe. Yellow injection electroluminescence has also been found in quasi-homojunctions between n-type ZnSe and p-type ZnTe grown by a new epitaxial process. For unambiguous distinction of the various injection electroluminescence effects that can be produced in one n-type ZnSe crystal, a comparative study was undertaken that yielded a set of simple criteria. The n-type ZnTe crystals were produced for the first time, and the phase diagram of ZnTe was established. Optical measurements on ZnSe-ZnTe mixed crystals were undertaken. A comprehensive theory of the luminescence centers in ZnS-ZnSe mixed crystals has been worked out, which is applicable also to other mixed crystals. Rare-earth-doped, luminescent zinc sulfide crystals were grown from the melt, and work on RE-doped films was begun. Author

**N65-12915#** Parke Mathematical Labs., Inc., Carlisle, Mass.
**INVESTIGATIONS ON ELECTRONIC INTERACTIONS IN MATERIALS AND ON DATA PROCESSING THEORY Final Report**
Oct. 1964 19 p refs
(Contract AF 19(628)-2417)
(AFCRL-64-870; AD-608512)

Abstracts of reports and technical memoranda are presented to summarize the research done. The publications on electronic interactions in materials include "A Diamond Bibliography;" "Application of the Mössbauer Effect to the Study of Internal Crystalline Fields;" and "Application of the Mössbauer Effect to the Study of Iron Garnets." The following are included under the study of data processing theory: "Basic Features Common to Some Combinational Covering Problems;" "Some Notes Concerning the Algebra of Input-Output Devices;" "Results concerning Device Algebra;" "Selected Annotated Bibliography on Systems of Theoretical Devices;" "A Mathematical Model for Input-Output Devices and Their Connections;" and "A Study of Substitution Operators for Boolean formulas." Also reviewed are the following reports: "Progressive Reliability Functions," "Approximate Solution of Integral Equations," "Integrals Needed for Calculating Molecular Orbitals," and "Molecular Orbital Calculation—A Specific Case." D.S.G.

**N65-12917#** Weizmann Inst. of Science, Rehovoth (Israel).
**PROPAGATION OF A COMPRESSIONAL PULSE IN A LAYERED SOLID Technical Note No. 10**
C. L. Pekeris, Z. Alterman, F. Abramovici, and H. Jarosh 10 Oct. 1964 41 p refs
(Contract AF 61(052)-509; Proj. Vela-Uniform)
(AFCRL-64-878; AD-608550)

The problem is solved for propagation of a compressional pulse in a solid half-space that is overlain by a solid layer of different properties. The point source is situated at the depth 1/2H, with H denoting the thickness of the layer. Theoretical seismograms of the vertical displacement w at the surface are evaluated out to ranges r = 20H. The solution is obtained by the exact ray theory. The displacement $w_0$ due to the source was assumed to have a shape that, at large distances, reduces to a sawtooth. The once-reflected waves from the interface, PP and PS, are strongly marked. The Rayleigh wave is already recognizable at r = 5H, and is fully developed at r = 20H. Author

**N65-12927#** Brown U., Providence, R.I.
**RADIATION EFFECTS IN SEMICONDUCTORS Summary Report, Jun. 1964**
J. J. Loferski Wright-Patterson AFB, Ohio, ARL, Oct. 1964 58 p refs
(Contract AF 33(657)-8974)
(ARL-64-151; AD-608612)

Information is presented of use to persons engaged in irradiation experiments involving electrons or protons with energies between 0 and 400 keV. Range energy curves for these particles, based on a critical review of the literature, are shown. A circuit for stabilizing the output voltage and current of a Van de Graaff machine is described. The results of a calibration of the machine based on a p,$\gamma$ reaction are presented. Radiation damage experiments in GaAs based on studies of changes in recombination radiation induced by electron-beam injection are described. Also reported is an experiment designed to demonstrate the existence of a photovoltage between two parts of a semiconductor with different lifetimes, the lifetime difference having been produced by irradiation. Author

**N65-12932#** Air Force Cambridge Research Labs., Bedford, Mass. Solid State Sciences Lab.
**LOW-TEMPERATURE FAR-INFRARED SPECTRA OF GERMANIUM AND SILICON Physical Sciences Research Papers No. 34**
Peter J. Gielisse, James R. Aronson, and Hugh G. Mc Linden (Little (Arthur D.) Inc., Cambridge, Mass.) Jun. 1964 17 p refs
(AFCRL-64-491; AD-608414)

New high-resolution low-temperature (7.5° K) far-infrared data on intrinsic germanium and silicon are presented. The findings further substantiate the naturally anticipated similarities in band patterns of the vibrational spectra of diamond-type crystals. The low-temperature spectra of germanium and silicon clearly show resolved splits in their principal absorption bands analogous to the intriguing doublet in the ca. 2000 $cm^{-1}$ band in diamond. A possible explanation is indicated. The room-temperature far-infrared refractive index of both germanium and silicon and the 7.5° K refractive index of germanium were measured by means of interference fringes.
Author

**N65-12933#** Westinghouse Electric Corp., Pittsburgh, Pa. Westinghouse Research Labs.
**TEMPERATURE DEPENDENCE OF PARAMAGNETIC RELAXATION AT POINT DEFECTS IN VITREOUS SILICA Scientific Report No. 5**
J. G. Castle, Jr. and D. W. Feldman 17 Jun. 1964 21 p refs
(Contract AF 19(628)-1640)
(AFCRL-64-643; AD-608625)

Spin relaxation was measured at 3 kOe and at lattice temperatures from 1.24° K to 250° K for the E′ centers generated in one type of vitreous silica by 2 MeV gamma rays. An unusual temperature dependence was found in which the spin-lattice relaxation time varies roughly as $T^{-2.5}$ over most of the range. All of the data are accurately fitted by analytical functions derived from a coupling of the individual defect centers to the vitreous host involving excess local strain due to mechanical resonances of about $4.1 \times 10^{11}$ cps and $6.0 \times 10^{12}$ at each E′ center. The strength of mechanical resonance is similar to that in crystalline $SiO_2$. Author

**N65-12934#** Westinghouse Electric Corp., Pittsburgh, Pa. Westinghouse Research Labs.
**SPIN-LATTICE RELAXATION OF Ti(+ 3) IONS IN CORUNDUM: TEMPERATURE DEPENDENCE AT 9 Gc FOR $\theta = 0$ Scientific Report No. 4**
D. W. Feldman, D. C. Burnham, and J. G. Castle, Jr. May 1964 20 p refs
(Contract AF 19(628)-1640)
(AFCRL-64-665; AD-608624)

Spin relaxation was measured at 9 Gc for several samples of titanium doped $Al_2O_3$, over the temperature range from 1.3° to 14° K. The spin-lattice relaxation time, $T_1$, for the portion of the paramagnetic resonance line at $\theta = 0$ having $g_{\parallel} = 1.05$ to 1.10, has values varying from 5 sec to $5 \times 10^{-3}$ sec according to the expression

$$1/T_1 = BT + CT^9 + D\exp(-\delta/T),$$

where $B = 0.13\,sec^{-1}\,°K^{-1}$, $C = 7(10^{-4})\,sec^{-1}\,°K^{-9}$, $D = 2.5(10^{10})\,sec^{-1}$, and $\delta = 52 \pm 1°$ K. These results are discussed in terms of spin-lattice interactions for individual Ti(+3) ions. In particular, the value of $\delta$ is assigned to the spin-orbit splitting between the lowest pair of electronic doublets for the configuration that may be approximately described as $3d^1$. Effects of covalency are mentioned. Author

**N65-12968#** IIT Research Inst., Chicago, Ill.
**STUDY OF COMPREHENSIVE FAILURE THEORY Final Report**
M. E. Goldberg, A. Horberg, H. A. Lauffenburger et al Griffiss AFB, N.Y., RADC, Sep. 1964 241 p refs
(Contract AF 30(602)-3054)
(IITRI-E6006-11; RADC-TDR-64-309; AD-608365)

Precipitation and oxidation are described as two principal failure mechanisms in deposited metal-film resistors. Resistors aged in the absence of oxygen show reduction of resistance with time. Evidence of clustering is obtained. Resistors exposed to oxygen at high temperature show increase in resistance with time. Experiments with quartz crystals show a fourth-power relationship for the oxidation kinetics. A mathematical model of resistor behavior, involving oxidation and precipitation, was programed for the IBM-7090 computer. Results agree poorly with resistor test data because of effects and mechanisms not yet incorporated in the model, and because the data available for validation studies represent mean value data for hundreds of resistors. In the model, the thickness of the resistive film is a most significant parameter; in the available mean value data many thicknesses are represented. Studies of failure mechanisms point to ionic contaminant migration as the probable first-order failure mechanism.
Author

**N65-12970#** Hughes Aircraft Co., Fullerton, Calif.
**IMPROVED DELAY LINE TECHNIQUES Final Report**
Lisle M. Sanborn Griffiss AFB, N.Y., RADC, Oct. 1964 129 p refs
(Contract AF 30(602)-2987)
(FR64-15-59; RADC-TDR-64-356; AD-608361)

Ultrasonic dispersive delay lines operating at ultrahigh frequencies were investigated. Data compiled from a study of a breadboard delay line are presented. Limits on operating parameters are analyzed and discussed. Techniques necessary for the construction of high-performance dispersive lines are developed, and details are given. Computations were conducted with the aid of an IBM-7090 Computer. Author

**N65-12973#** General Telephone and Electronics Labs., Inc., Bayside, N.Y.
**STUDY OF ADSORPTION OF GASES ON SOLIDS IN THE HIGH VACUUM RANGE Scientific Report No. 8**
J. V. Florio 30 Sep. 1964 18 p refs
(Contract AF 19(628)-331)
(AFCRL-64-822; TR-64-255.8; AD-608520)

The work function of polycrystalline tungsten has been measured, using the retarding field technique, as a function of

the exposure to a carbon monoxide ambient. The work function was found to vary from 4.4 to 5.2 eV in going from an initially clean surface to one saturated with carbon monoxide. The successive adsorption of oxygen on a tungsten surface already saturated with carbon monoxide is inferred from the work-function data. The increase in work function (from 5.2 to 6.4 eV) is indicative of a monolayer or more of adsorbed oxygen. The work functions for a clean (111) silicon surface, silicon exposed to $3 \times 10^{-6}$ torr-sec oxygen, and silicon exposed to $9 \times 10^{-6}$ torr-sec oxygen were found, by the retarding field method, to be 4.79 eV, 5.02 eV, and 5.07 eV, respectively. Author

**N65-12997#** Delaware U., Newark.
**CHARACTERISTIC FIELD INHOMOGENEITIES IN HOMOGENEOUS DIELECTRICS IN THE PRE-BREAKDOWN RANGE Technical Report No. 1**
K. W. Böer and James Ralph Green (M.S. Thesis) Sep. 1964 114 p refs Thesis submitted under the title "The Effects of Infrared and Ultraviolet Radiation on Layer-like Field Distributions in Cadmium Sulfide"
(Contract DA-31-124-ARO(D)-173)
(AROD-4461-1; AD-608273)

Layer-like field inhomogeneities can form in CdS at high field strengths. By simultaneously illuminating CdS crystals with visible light near the absorption edge and with infrared or ultraviolet radiation, it is possible to visually observe the effects of infrared and ultraviolet excitation on the layer-like field inhomogeneities. Photographs are presented showing that the layer-like field inhomogeneities can be either created or destroyed by infrared and ultraviolet illumination, depending upon the intensity and distribution of the radiation. Author

**N65-13034#** Purdue Research Foundation, Lafayette, Ind.
**SEMICONDUCTOR RESEARCH Semiannual Report, Apr. 1–Sep. 30, 1964**
H. Y. Fan et al [1964] 33 p refs
(Contract DA-31-124-ARO(D)-17)
(PRF-3224; AD-450586)

Progress is reported in the following fields: Electrical and Optical Properties—energy distribution functions and the energy loss mechanisms of hot carriers in p-type germanium, properties of a displaced Maxwellian distribution function, magnetoresistance oscillations in n-GaSb, temperature dependence of the electrical resistivity in n-type GaSb, interaction of magnetoplasma and longitudinal plasma waves in solids, stress induced donor deionization in n-GaAs, piezoresistance of n-AlSb, and excitation spectra of lithium donors in silicon; Irradiation Effects—electron paramagnetic resonance in neutron-irradiated silicon and in electron-irradiated germanium; Low Temperature Studies—specific heat of lead and lead alloys between 0.4 and 4.2° K, and thermal conductivity in n-type Ge; and General—X-ray lattice parameter and line width studies in silicon. G.G.

**N65-13041#** Army Signal Research and Development Agency and Lab., Fort Monmouth, N.J. Electronic Components Dept.
**BEAM DIVERGENCE AND FAR-FIELD PATTERNS OF RUBIES OF VARYING OPTICAL QUALITY**
C. M. Kellington and M. Katzman Jul. 1964 23 p refs
(ECOM-2478; AD-608717)

Beam divergence at 10 dB from extinction was measured, and far-field patterns were photographed for 37 ruby rods of different quality. The growth with pumping power of the most intense portion of the laser beam was measured for two rods of very different quality. An autocollimator reticle image was photographed after passage through each rod. Correlation of beam divergence with optical parameters is discussed. Author

**N65-13071#** International Business Machines Corp., Yorktown Heights, N.Y. Thomas J. Watson Research Center
**PHONON INTERACTIONS IN CRYSTALS Fifth Quarterly Progress Report, 15 May–14 Aug. 1964**
A. H. Nethercot, M. Pomerantz, and N. S. Shiren [1964] 32 p refs
(Contract DA-36-039-AMC-02280(E))
(Rept.-5; AD-451235)

The amplification of microwave phonons in germanium was observed. Gains as large as 20 dB at 9 Gc/sec have been observed. Maser amplification of ultrasonic waves, following adiabatic rapid passage inversion of $Fe^{2+}$ and $Ni^{2+}$ spin systems in MgO, was also observed. The measured gains were ~20 dB/cm and 7 dB/cm for the $Fe^{2+}$ and $Ni^{2+}$, respectively. Also, an additional dynamic gain mechanism was observed under certain conditions. For the latter, the measured gains were ~30 dB/cm and ~18 dB/cm, respectively, for the two spin systems. A report on the transmission of heat pulses in alkali halides at low temperatures is included. Author

**N65-13109#** Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati
**DEPENDENCE OF IONIC MOBILITIES IN LIQUID $He^3$ ON TEMPERATURE AND DENSITY**
P. de Magistris, I. Modena, and F. Scaramuzzi 9 Oct. 1964 6 p refs Presented at 9th Conf. on Low Temp. Phys., Columbus, Ohio, 1964 Submitted for Publication *Its* Nota Interna No. 259
(LNF-64/48)

Two different techniques were used to measure the mobility of positive and negative ions in liquid $He^3$ as a function of temperature and density of the liquid. One technique consists of the measurement of the time-of-flight of ions between two electrodes whose distance is known. The second method is based on the measurement of the voltage-current characteristics of a diode in condition of complete space charge limitation. The experimental data did not fit any satisfactory theory. R.L.K.

**N65-13169#** Harvard U., Cambridge, Mass. Gordon Mc Kay Lab.
**THE EFFECT OF PRESSURE ON OPTICAL PROPERTIES OF SEMICONDUCTORS**
Richard Zallen Aug. 1964 150 p refs
(Contract Nonr-1866(10))
(HP-12; AD-607047)

Measurements of the effect of hydrostatic pressure on optical properties of group 4 and group 3–5 semiconductors in the infrared, visible, and near-ultraviolet regions of the spectrum are described. The results of these experiments provide evidence in support of the empirical rule, inferred from earlier work on pressure effects, which states that energy separations of corresponding electronic states in related materials change with pressure at nearly the same rate. The correlation between pressure-coefficient and transition type permits investigation of electronic energy-band structure by means of optical-pressure experiments. This approach was taken to study the band structure of GaP. D.E.W.

**N65-13194#** Alfred U., N.Y. College of Ceramics
**THE STRESS-STRAIN BEHAVIOR OF STRONTIUM ZIRCONATE Final Technical Report, 15 Sep. 1963–15 Sep. 1964**
J. E. Funk, J. Nemeth, and J. R. Tinklepaugh [1964] 76 p refs
(Contract NOw-64-0051-d)
(AD-607173)

The mechanical yield of polycrystalline $SrZrO_3$ at room temperature appears related to a domain motion or crystal twinning similar to that which takes place in ferroelectric $BaTiO_3$ under an electric stress. This theory was supported by comparing experimentally determined yield to the expected yield from crystallographic considerations. Small single crystals were grown, and photographs revealed a laminar structure taken to be similar to those known to exist in $BaTiO_3$. This further supports the theory presented. Author

**N65-13199#** Naval Ordnance Lab., Corona Calif. Infrared Div.
**PERTURBATION THEORETICAL APPROACH TO MAGNETO-OPTICAL PHENOMENA IN THE NONABSORBING REGION**
A. Nedoluha *In its* Foundational Res. Proj. 1 Sep. 1964 p 1–16 refs (See N65-13198 03-06)

A general approach is established to magneto-optical phenomena in the nonabsorbing region of a system in an isolated ground state. It is stated that the result of the application of nondegenerate perturbation theory on the one-particle energy eigenstates represents not only a special case of the general result but is factually identical with it, even if the application of nondegenerate perturbation theory is not justified. The Green function method used seems to be the natural starting point for extensions of the present independent particle model. D.E.W.

**N65-13206#** Indiana U., Bloomington. Chemical Lab.
**APPLICATION OF IONIC BEAMS TO STUDY OF CORROSION OF METALS BY GASES Final Report, 1 Jul. 1960–15 Aug. 1963**
Walter J. Moore Oct. 1964 78 p refs
(Contract DA-33-008-ORD-1989)
(AROD-2692-1; AD-451245)

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**N65-13207#** Indiana U., Bloomington. Chemical Lab.
**EFFECTS OF ATOMIC OXYGEN ON SEMICONDUCTOR OXIDES**
Nguyen Trinh Dzoanh and Walter J. Moore *In its* Appl. of Ionic Beams to Study of Corrosion of Metals by Gases Oct. 1964 17 p refs (See N65-13206 03-26)

The increase in conductivity of an oxide crystal without doping caused by its departure from exact stoichiometry in the direction of excess oxygen is discussed in the typical case of nickel oxide. The behavior of this crystal in an atmosphere containing a controlled concentration of atomic oxygen was studied at a total pressure of about 0.3 torr and at temperatures up to 700° C. The effect of oxygen atoms is to increase the conductivity of the oxide. The effect is smaller at higher temperatures because the surface recombination coefficient of oxygen atoms on the oxide surface increases with temperature. The oxidation rate of pure copper foil in an atomic-oxygen atmosphere at 850° was only slightly greater than that in molecular oxygen, a result that also indicates a rapid surface recombination of atomic oxygen. Author

**N65-13209#** Indiana U., Bloomington. Chemical Lab.
**CORROSION OF METAL FILMS IN AN OXYGEN PLASMA AT HIGH PRESSURE**
Jens Traetteberg, Nguyen Trinh Dzoanh, and Walter J. Moore *In its* Appl. of Ionic Beams to Study of Corrosion of Metals by Gases Oct. 1964 11 p refs (See N65-13206 03-26)

The oxidation of thin films of aluminum and copper by anodization in an oxygen plasma cell at one atmosphere and at room temperature was studied by means of an electron microscope. The oxide film formed by the oxygen plasma is torn into fissures by both electrical and thermal breakdown over the surface of the metal electrode. Selected area diffraction revealed the existence $\delta Al_2O_3$ with aluminum films and $Cu_2O$ and CuO with copper films. Nucleation and growth of oxide below the outer surface of metal may be expected as a result of oxygen-ion bombardment from the plasma. Author

**N65-13210#** Indiana U., Bloomington. Chemical Lab.
**OXIDATION OF ALUMINUM FILMS AFTER IONIC BOMBARDMENT WITH HELIUM OR XENON**
Walter J. Moore, Sigemaro Nagakura, and Sylvester Brown *In its* Appl. of Ionic Beams to Study of Corrosion of Metals by Gases Oct. 1964 12 p (See N65-13206 03-26)

Chemisorption of oxygen at 25° C has been measured on aluminum films prepared by evaporation in a high-vacuum system ($10^{-8}$ to $10^{-9}$ torr). The films were in some cases impregnated with helium or xenon by cathodic bombardment in a plasma or glow discharge. Occluded inert gases that could not be pumped off at 25° C were rapidly released on exposure of the treated film to oxygen. Author

**N65-13219#** India. Dept. of Atomic Energy, Bombay.
**PROCEEDINGS OF THE NUCLEAR PHYSICS AND SOLID STATE PHYSICS SYMPOSIUM, 1964. PART B: SOLID STATE PHYSICS**
[1964] 312 p refs Eighth Ann. Symp. held at Panjab U., Chandigarh, India, 24–28 Feb. 1964

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36. MAGNETIC STRUCTURES IN THE IRON-GERMANIUM SYSTEM N. S. Satya Murthy, C. S. Somanathan, R. J. Begum, and M. R. L. N. Murthy (Atomic Energy Estab. Trombay, Bombay) p 543–548 refs

37. ATOMIC MOTIONS IN LIQUID ARGON B. A. Dasanacharya and K. R. Rao (Atomic Energy Estab. Trombay, Bombay) p 549–555

38. DISLOCATION MOTION IN SODIUM CHLORIDE CRYSTALS P. G. Deo and S. D. Sharma (Panjab Eng. Coll., Chandigarh) p 556–558 refs

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43. STUDY ON THE STRUCTURE OF COLLAGEN S. D. Bhattacharya, S. Das, N. N. Saha, and A. K. Saha (Saha Inst. of Nucl. Phys., Calcutta) p 601–611 refs

44. MICRO-INDENTATION STUDIES IN SINGLE CRYSTALS OF TIN Chuni Lai and S. D. Sharma (Panjab Eng. Coll., Chandigarh) p 612–613 refs

45. STUDY OF STRUCTURAL TRANSFORMATION IN THIN FILMS OF $Ag_2Te$, $Ag_2Se$, $Cu_2Se$, AND $Cu_2Te$ BY ELECTRON DIFFRACTION S. K. Sharma (Natl. Phys. Lab., New Delhi) p 614–619 refs

**N65-13275*#** Rice U., Houston, Tex.
**RESEARCH ON THE PHYSICS OF SOLID MATERIALS Semiannual Status Report No. 11, 1 May–31 Oct. 1964**
Franz R. Brotzen 3 Dec. 1964 20 p refs
(Grant NsG-6-59)
(NASA-CR-59906) OTS Prices: HC $1.00/MF $0.50

Research was conducted in the following fields: "Solid State Physics"—paramagnetic, phonon–phonon, and phonon–magnon interactions, laser research, superconductivity of niobium, and mechanics of magnetic ordering; "Physical Metallurgy"—mainly observed was the transmission electron microscopy of Au-Co-alloys, dislocation contrast, microcreep in molybdenum single crystals, ultrasonic attenuation of LiF crystals between 2° and 300° K, short-range-order and electrical resistivity in fcc alloys, and interrelation of the electronic structure and the nature of crystalline defects in semiconductors; "Chemistry of Solids"—order–disorder analysis of lattice system, high-temperature interactions between gases and condensed phases, and the crystal structure of complex molecules. G.G.

**N65-13286#** Michigan U., Ann Arbor. Electron Physics Lab.
**SOLID-STATE MICROWAVE RESEARCH Interim Scientific Report No. 4, Jul. 1–Oct. 1, 1964**
D. C. Hanson, J. E. King, J. E. Rowe, and C. Yeh Oct. 1964 28 p refs
(Contract AF 33(657)-11587)
(Rept.-06031-4-S; AD-450477)

A brief discussion is given on the parametric interactions expected in vanadium-doped cadmium sulfide. Extensive experimental work on observing radiation from GaAs samples is reported for both n-type and p-type units of various doping concentrations. Small-area samples have been studied, and the radiation appears to be concentrated in the 4$\mu$ to 40$\mu$ wavelength range. The theory of deformation potential phonon-wave amplifiers is outlined and discussed. Different coupling mechanisms are considered, and the effects of drift fields and frequency are considered. A spin-wave transducer program has been initiated, and the use of thin CdS films, such as microwave coupling transducers, is outlined. Author

**N65-13302#** Snelgrove (C.R.) Co., Ltd., Don Mills (Canada).
**RESEARCH AND DEVELOPMENT ON CRYSTAL FILTERS Quarterly Reports, 1 Mar.–1 Sep. 1964**
Louis Buncak [1964] 30 p
(Contract PW-69-200020)
(QR-5; QR-6; AD-449693)

This report deals with design consideration of plano–convex crystal resonators. Empirical formulas were derived for the crystal electrical parameters. With these formulas the electrical parameters can be calculated from the physical constants of the crystal plate. Some of these formulas are believed to be original. A large number of crystals were measured, their spurious modes identified, and the U factors calculated. The effect of the electrode size on the spurious modes was studied. The U factor bar charts of several crystals were computed and plotted to show the spurious modes with different electrode sizes. Author

**N65-13308*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**ANOMALOUS ELECTRICAL RESISTIVITY OF PALLADIUM–DEUTERIUM SYSTEM BETWEEN 4.2° AND 300° K**
Robert J. Smith Washington, NASA, Jan. 1965 10 p refs
(NASA-TN-D-2568) OTS Prices: HC $1.00/MF $0.50

The electrical-resistivity data of the palladium–deuterium (Pd-D) system with an atom ratio D/Pd of approximately 0.65 contain a peak near 40° K. This peak is similar to that obtained for the palladium–hydrogen (Pd-H) system and is accounted for by octahedral–tetrahedral transitions of some of the deuterium ions in the face-centered-cubic lattice of palladium. The resistivity is proportional to the temperature between 110° K and room temperature, as might be expected for palladium with a filled d-band; however, this relation is nonlinear for the Pd-H system, which indicates a broader temperature range for octahedral–tetrahedral transitions by hydrogen ions. Author

**N65-13334#** Optics Technology, Inc., Belmont, Calif.
**LONG WAVELENGTH INFRARED FIBER OPTICS Interim Engineering Report, Jun. 15–Sep. 15, 1964**
N. S. Kapany and R. J. Simms Sep. 1964 32 p refs
(Contract AF 33(615)-1952)
(IER-1; AD-607323) OTS: $2.00

The results of a literature survey for glasses with longer wavelength infrared transmission than arsenic–sulphur glasses are described in detail. The conclusions of this survey are discussed, and samples have been obtained of some of the selected glasses. The equipment necessary for this program is described, and progress on its fabrication is reported. Preliminary attempts to draw fibers with the available samples using existing fiber drawing equipment have indicated that closer environmental control is necessary to produce seed-free fibers. This was anticipated, and new equipment is now being built. Author

# 27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

**N65-12552#** Lockheed Propulsion Co., Redlands, Calif.
**SOLID PROPELLANT STRUCTURAL INTEGRITY INVESTIGATIONS: DYNAMIC RESPONSE AND FAILURE MECHANISMS, VOLUME I Quarterly Progress Report No. 1, 15 Jun.–15 Sep. 1964**
D. E. Cantey 14 Oct. 1964 118 p refs *Its* Rept.-667-Q-1
(Contract AF 04(611)-9953)
(AFRPL-TR-64-148, Vol. I; AD-452689)

The results are reported of an investigation of viscoelastic and failure properties of highly filled PBAA and PBAN propellants as a function of solids loading. The temperature rise in shear specimens under constant large-amplitude dynamic strains was investigated and compared with analytical predictions. The theory of thermomechanical effects is extended to include inertia-loading and stationary random-loading conditions. Initial results obtained from piezoelectrical test devices for measuring dynamic bulk and shear properties of propellants are reported. Propellant cross-link density and gel fraction measurements were made. Physicochemical aspects of nitroplastisol propellants are discussed. The effects of solid-particle-size distribution on flow properties in the uncured state and on the physical properties of the cured propellant are described. Author

**N65-12704*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**PERFORMANCE AND OPERATIONAL CHARACTERISTICS OF PENTABORANE FUEL IN 48-INCH-DIAMETER RAM-JET ENGINE**
Warren D. Rayle, Dwight H. Reilly, Jr., and John M. Farley Washington, NACA, 24 Apr. 1957 27 p refs
(NACA-RM-E55K28) OTS Prices: HC $2.00/MF $0.50
(Declassified)

Pentaborane was used as the fuel for a 48-inch-diameter ramjet engine in two brief tests in a free-jet facility. Each test lasted about 50 seconds, and through the use of fast-response instrumentation and prescheduled fuel-flow variation provided data on the engine performance for fuel-air ratios from about 0.020 to 0.030. The flameholder and fuel-injector systems were especially designed for use with this fuel. For both tests, the combustor-inlet temperature was 530° F; the combustor pressure level was about 1/3 atmosphere; and the combustor-inlet Mach number was about 0.15. Combustor lengths of 8 and 6 feet were used for the first and second tests, respectively. The combustion efficiencies determined with the 8-foot combustor length decreased from 89 to 84 percent as the fuel–air ratio increased from 0.018 to 0.029. The second test, with a 6-foot combustor length, was carried out with slightly different flow conditions. The combustion efficiencies ranged from 86 to 79 percent as the fuel–air ratio increased from 0.020 to 0.030. The specially designed fuel-injector system operated satisfactorily for both tests, with no indication of any clogging of the orifices. Author

**N65-12709*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**EVALUATION OF HYDROGEN FUEL IN A FULL-SCALE AFTERBURNER**
Donald E. Groesbeck, William R. Prince, and Carl C. Ciepluch Washington, NASA, 24 Sep. 1957 41 p refs
(NACA-RM-E57H06) OTS Prices: HC $2.00/MF $0.50
(Declassified)

A performance investigation using hydrogen fuel in a full-scale afterburner was conducted with particular study of fuel-injector configurations and afterburner length. A total of seven fuel-injector configurations, grouped by type as concentric ring or radial bar, were investigated at a burner-inlet velocity of approximately 600 ft/sec over a range of burner-inlet total pressures from 330 to 950 pounds per square foot absolute. Afterburner length was varied from 27 to 69 inches. No flame-stabilizing devices other than the fuel injectors were used. Data presented indicate that maximum combustion efficiencies at a balanced-cycle condition for a ring-type fuel injector in a 39-inch burner were 94% and 78% for burner pressures of 890 and 488 pounds per square foot absolute, respectively. Increase in afterburner equivalence ratio beyond that for peak efficiency resulted in a serious drop-off in combustion efficiency. Variation in fuel-injector variables did not significantly affect combustion efficiency. Author

**N65-12946#** Space Technology Labs., Inc., Redondo Beach, Calif.
**A CALIBRATED ENGINE PROPELLANT LOADING CONCEPT**
R. S. Don and J. M. Frank 20 Sep. 1963 22 p
(STL-6110-8762-RU-000)

This report describes the principles associated with the use of propellant loading constraints to induce balance within a bipropellant rocket system so that simultaneous depletion of both propellants occurs at burnout. An optimum relation governing the specification of loading requirements is also developed. R.L.K.

**N65-13293#** Rohm and Haas Co., Huntsville, Ala.
**BALLISTIC EVALUATION OF PROPELLANTS IN MICRO-MOTORS**
Byron L. Cockrell 22 Oct. 1964 119 p refs
(Contracts DA-01-021-ORD-11878(Z); DA-01-021-ORD-11909(Z))
(S-49; AD-451357)

An extensive series of static tests showed that specific impulse could be scaled when corrections were made for heat-loss and two-phase-flow effects. These scaling factors were obtained from a series of micromotor tests requiring as little as 2 pounds of propellant. The areas of system design features, motor preparation and assembly, ignition, data acquisition, data reduction, scaling effects, scaling-factor determination, and specific-impulse prediction were treated in considerable detail. Author

**N65-13306*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**PHOTOGRAPHIC STUDY OF PROPELLANT OUTFLOW FROM A CYLINDRICAL TANK DURING WEIGHTLESSNESS**
Ralph C. Nussle, Joseph D. Derdul, and Donald A. Petrash Washington, NASA, Jan. 1965 14 p refs
(NASA-TN-D-2572) OTS Prices: HC $1.00/MF $0.50

The problems associated with the behavior of rocket engine propellants stored in space vehicle tanks while exposed to weightlessness are being studied. As part of this overall study, a photographic investigation was conducted to examine the behavior of the liquid–vapor interface during pumping or outflow from a cylindrical tank in a zero-gravity environment. The results indicate that significant distortion of the interface occurs as the outflow velocity is increased. The effects of diffusing the incoming pressurizing gas and baffling the tank outlet were to minimize the interface distortion and to delay vapor blow-through. Author

# 28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magneto-hydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

**N65-12505*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**BLAST EFFECTS OF TWIN VARIABLE-CANT ROCKET NOZZLES ON VISIBILITY DURING LANDING ON A PARTICLE-COVERED SURFACE**
George J. Hurt, Jr. and Lindsay J. Lina Washington, NASA, Dec. 1964 69 p refs
(NASA-TN-D-2455) OTS Prices: HC $1.75/MF $0.75

A limited investigation has been conducted to determine the jet-blast effect of twin variable-cant supersonic nozzles. These tests were made to examine the result of using canted main rocket engines to sweep the blast debris outward from the proposed landing area of a rocket-powered vehicle making a vertical approach to a touchdown. Cant angles from 0° to 75°, at intervals of 15°, were tested at low ambient pressure and at atmospheric ambient pressure. Nozzle chamber pressures used were 400 psi and 2000 psi. Author

N65-12703*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**INFLUENCE OF BORIC OXIDE DEPOSITION ON TURBOJET-ENGINE OPERATION**
James W. Useller, Richard R. Burley, and Wallace W. Velie Washington, NACA, 15 Feb. 1957 28 p ref
(NACA-RM-E55B09) OTS Prices: HC $2.00/MF $0.50
(Declassified)

To understand better the effect of oxide-depositing fuels on engine starting, operation, and performance, a modified production turbojet engine was operated using a trimethyl borate azeotrope as a fuel. Trimethyl borate, a comparatively low-heating-value fuel that forms boric oxide during combustion, was used as a substitute for the more expensive and less available boron hydride fuels. Operation with trimethyl borate for 100 minutes produced a 2% deterioration in engine speed and only a 1% increase in combustor total-pressure loss with the best engine configuration investigated. The deposits had no measurable effect on the turbine efficiency. Following the operation with trimethyl borate fuel, the engine was operated with a hydrocarbon fuel (JP-4) to dissipate the boric oxide deposits. After 50 minutes of operation with JP-4 fuel, the deposits were substantially removed and the engine approached normal operation. Author

N65-12706*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**PERFORMANCE AT SIMULATED HIGH ALTITUDES OF A PREVAPORIZING ANNULAR TURBOJET COMBUSTOR HAVING LOW PRESSURE LOSS**
Carl T. Norgren Washington, NACA, 6 Dec. 1956 43 p refs
(NACA-RM-E56I14) OTS Prices: HC $2.00/MF $0.50
(Declassified)

An annular prevaporizing turbojet combustor having pressure losses lower than those obtained in current turbojet combustors was developed. Pressure losses of 2 to 4 percent, satisfactory temperature profiles, and combustion efficiencies of 98, 88, and 81 percent were obtained at 56 000, 70 000, and 80 000 feet, respectively, for a simulated 5.2-pressure-ratio engine at rated speed and 0.6 flight Mach number with JP-4 fuel. Use of JP-5 fuel resulted in a small penalty in efficiency due, in part, to insufficient prevaporizer capacity. Author

N65-12712*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**PERFORMANCE OF A 28-INCH RAMJET UTILIZING GASEOUS HYDROGEN AT A MACH NUMBER OF 3.6, ANGLES OF ATTACK UP TO 12°, AND PRESSURE ALTITUDES UP TO 110,000 FEET**
Norman T. Musial, James J. Ward, and Joseph F. Wasserbauer Washington, NACA, 19 May 1958 25 p refs
(NACA-RM-E58A23) OTS Prices: HC $1.00/MF $0.50
(Declassified)

An investigation was conducted in the NACA Lewis 10- by 10-foot supersonic wind tunnel to evaluate the performance of a shrouded injector burner with perforated domes employed in a 28-inch ramjet using gaseous hydrogen as fuel. Steady-state data were obtained at a pressure altitude of 77 000 feet and zero angle-of-attack. Transient data were obtained at pressure altitudes up to 110 000 feet and angles-of-attack up to 12°. Results of this investigation showed that burning could be initiated under severe distortion conditions and that satisfactory combustor operation was accomplished up to a pressure altitude of 110 000 feet with no adverse effect on combustion efficiency. Shortening the combustion chamber decreased the combustion efficiency at the higher equivalence ratios. Author

N65-12713*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**AN ACCELERATION SCHEDULE CONTROL FOR ACCELERATING A TURBOJET ENGINE AND ITS USE WITH A SPEED CONTROL**
Theodore F. Gerus, Albert G. Powers, and Herbert J. Heppler Washington, NACA, 12 May 1958 36 p refs
(NACA-RM-E58B19) OTS Prices: HC $2.00/MF $0.50
(Declassified)

An acceleration-limiting control was used on a turbojet engine in order to study the feasibility of its use as an acceleration control. A proportional-plus-integral type of controller was used in this investigation. Transient response data were obtained to investigate the control-system response and stability. The response was evaluated in terms of schedule overshoot and acceleration time as a function of control-parameter settings and input disturbance rate. Both schedule overshoot and acceleration time were found to be a function of rate-of-input disturbance, schedule level, system gain, and controller time constant. All these parameters, therefore, must be adjusted to provide a compromise between fast acceleration and small overshoot. Author

N65-12796*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**PERFORMANCE OF A VARIABLE DIVERGENT-SHROUD EJECTOR NOZZLE DESIGNED FOR FLIGHT MACH NUMBERS UP TO 3.0**
Andrew J. Stofan and James R. Mihaloew Washington, NASA, Jan. 1961 51 p refs
(NASA-TM-X-255) OTS Prices: HC $3.00/MF $0.50
(Declassified)

The performance of a continuously variable ejector nozzle designed for operation at flight Mach numbers up to 3.0 was evaluated in a 0.25-scale investigation conducted on a series of fixed configurations simulating the various positions of the variable ejector nozzle. The investigation was conducted in an unheated quiescent-air test facility to determine the pumping and internal-thrust performance of the ejector. The ejector shroud had a shortened isentropic-design internal contour. The thrust performance and pumping characteristics of the ejector were determined over a range of nozzle pressure ratios from 2 to 24, while the ejector-corrected weight-flow ratio was varied from 0 to 0.22. The ejector-thrust ratio varied from about 0.983 to 0.993 throughout the range of operable conditions. The pumping performance was adequate to provide sufficient secondary air for cooling. Author

N65-12827# Pratt and Whitney Aircraft, West Palm Beach, Fla. Florida Research and Development Center
**RECENT ADVANCES IN THE DEVELOPMENT OF THE RL10 ROCKET ENGINE**
B. N. Torell 10 Nov. 1964 20 p
(PWA-FR-1190)

The liquid oxygen–liquid hydrogen RL10-rocket engine, which has successfully provided upper stage propulsion for Centaur and Saturn vehicles, has reached an advanced state of development as a fixed-thrust engine. Programs continue to demonstrate the feasibility of several features that have application to many possible future space mission requirements, such as soft lunar or planetary landings and orbital rendezvous. These features include operation in a pressurized mode at very low thrust levels, hypergolic ignition, throttling to 10 percent of rated thrust, and reduced propellant pump net positive-suction pressure requirements. This paper describes the progress of this effort to date, and reviews the associated problems. Author

# 29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

**N65-12572#** Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
**SPECTRAL TRANSMISSIVITY OF THE EARTH'S ATMOSPHERE IN THE 250 TO 500 WAVE NUMBER INTERVAL. PART II: A CASE STUDY OF THE ATMOSPHERIC ENVIRONMENT ALLOWING TRANSMISSION OF 24 MICRON WAVELENGTH SOLAR RADIATION TO SEA LEVEL**
Glenn B. Hoidale, Charles W. Querfeld, James T. Hall, and Ramon Mireles Nov. 1964 18 p refs
(ERDA-201; AD-450989)

Atmospheric transmission of solar radiation of 24$\mu$ wavelength was observed at a sea-level site in Death Valley National Monument, California, on 15 March 1963. This report briefly describes the atmospheric environment that allowed this transmission. Analysis of surface and upper-air pressure-moisture patterns and space and time cross sections leads to the conclusion that the observed transmission was permitted by a column of extremely dry and cold air passing over the Death Valley site during the afternoon of 15 March. This report is the second of a series treating the spectral transmissivity of the earth's atmosphere in the 20$\mu$ to 40$\mu$ band of the far infrared. Author

**N65-13024#** Aeronutronic, Newport Beach, Calif. Aeronutronic Div.
**ENVIRONMENTAL EFFECTS OF PHOTOSENSITIVE MATERIALS**
John H. Atkinson, Jack D. Calvert, G. E. Cook, and J. F. Parham Wright-Patterson AFB, Ohio, AF Avionics Lab., Oct. 1964 76 p
(Contract AF 33(616)-8261)
(AFAL-TR-64-274; AD-608418)

Development of an experimental device for use in a probe or orbital space vehicle to collect data on the nature and effects of space environmental radiation on gelatin–silver–halide emulsions is reported. The flight instrumentation package is to include a film supply, image processor, image data readout device, and data processing circuitry compatible with standard research vehicle telemetry. An experimental laboratory unit was developed that incorporates a film processor, photodensitometer, and radiation counter. The operation of the unit is controlled by an electromechanical programmer and is capable of continuous automatic processing of a roll of film. Supporting investigations of rapid processing of selected aerial films and the results of an investigation of web processing techniques are also reported. D.E.W.

**N65-13028#** Chicago U., Ill. Lab. for Astrophysics and Space Research.
**COSMIC RAY NEUTRON INTENSITY MONITOR**
John A. Simpson *In* AFCRL Geophys. and Space Jul. 1964 29 p refs (See N65-13026 03-13)
(Contract AF 19(628)-2473)

Data are presented by hour and day that were obtained during January, February, and March, 1964, from neutron monitors at Chicago, Illinois; Climax, Colorado; and Huancayo, Peru. D.E.W.

**N65-13031#** Harvard Coll. Observatory, Fort Davis, Tex.
**SOLAR RADIO EMISSION. SPECTRAL OBSERVATIONS**
Alan Maxwell *In* AFCRL Geophys. and Space Jul. 1964 5 p (See N65-13026 03-13)
(Contract AF 19(628)-2370)

Data are presented on solar radio emission in the spectral range 50-320 Mc/sec recorded at Fort Davis, Texas. The following activity is listed: noise storms, slow-drift bursts, groups of fast-drift bursts with more than 10 individual bursts, and continuum bursts. Idealized examples of the bursts are shown. D.E.W.

**N65-13236*#** Massachusetts Inst. of Tech., Cambridge.
**A SOLAR WIND DEUTERIUM DETECTOR AND CHARGE SPECTRUM ANALYZER**
Franklin Weaver Floyd, Jr. (M.S. Thesis) Nov. 1964 81 p refs (Grant NsG-386)
(NASA-CR-59788) OTS Prices: HC $3.00/MF $0.75

An instrument for satellites or space probes is described that will measure the relative abundance in the solar wind of the hydrogen isotope, deuterium, and possibly of the helium isotope, $He^3$. It will also reveal the relative abundances of certain light positive ions by measuring the charge-spectrum of the solar wind up through a positive charge of about eight times the proton charge. A laboratory model of the instrument is described. The results of preliminary tests in vacuum show the concepts to be feasible. The results of these tests are discussed, and suggestions are made for further development of the instrument. Author

**N65-13325#** International Geophysical Year World Data Center A, Boulder, Colo.
**OBSERVATIONS OF JUPITER'S SPORADIC RADIO EMISSION IN THE RANGE 7.6-41 Mc/s FOR THE YEARS 1960–1963 IGY Solar Activity Report Series No. 28**
James W. Warwick and William T. Kreiss 2 Nov. 1964 98 p

A catalog of Jupiter observations carried out with a swept-frequency interferometer is presented. The following data are included in the tables: observing period (the times during which the equipment could have detected Jupiter emissions at the limiting sensitivity); Jupiter observations (the earliest and latest times at which emission was detected); intensity (estimated as to one of three classes of intensity); "burstiness" (smooth, weak, moderate, or strong); frequency range; and Jupiter longitudes (radio system longitudes, System III 1957.0). D.S.G.

# 30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

**N65-12341#** Hungarian Academy of Sciences, Budapest.
**SOME REMARKS ON EMPIRICAL TESTS OF COSMOLOGY**
G. Paal 1964 31 p refs *Its* Mitt. No.-54

In Abell's catalog of clusters of galaxies a strong correlation has been found between the compactness and the distance of the clusters. It is demonstrated in this paper that

this results from an error in Abell's working hypothesis, according to which the "angular diameter" of a cluster is inversely proportional to its mean red shift. In the case of distant clusters of galaxies the red shift is not even in rough proportion to distance. This statement is in disagreement with the opinion generally held by astronomers; it is, however, proved to be in perfect accord with the magnitudes and red shifts published by Humason, Mayall, and Sandage. When the correct relationship between the red shifts and the angular diameters of the clusters of galaxies is applied, the existence of a metagalactic density gradient different from zero may be inferred from the data of Abell's catalog. Author

**N65-12414*#** Texas U., Austin. Electrical Engineering Research Lab.
**AN INVESTIGATION OF 35 GC, 70 GC AND 94 GC CYTHEREAN RADIATION Technical Report No. 2**
C. W. Tolbert and A. W. Straiton 15 Oct. 1964 22 p refs
(Grant NsG-432)
(NASA-CR-59707; I-02) OTS Prices: HC $1.00/MF $0.50

The observing techniques and the results of measurements, conducted between 10 April and 22 August 1964, of emission from Venus at 35, 70, and 94 GC are reported. A 16-foot-diameter antenna system, in conjunction with conventional 10-Mc-if bandwidth radiometers, was used for the measurements. The average brightness temperatures during the observations were 375°, 330°, and 300° K at the frequencies of 35, 70, and 94 Gc, respectively. No large dependency of the brightness temperatures on the Cytherean phase at these millimeter wavelengths was noted. The brightness temperature-phase dependencies that were observed, in conjunction with the correlation of the millimeter-wavelength brightness temperatures and the Fraunhofer Institut sunspot indexes, and the good spectral description by an ionospheric model of both the millimeter-wavelength brightness temperatures and the centimeter-wavelength brightness temperatures of other observers, suggest that an ionospheric model is singularly the most suitable for describing the Cytherean radiation. Author

**N65-12420#** Boeing Scientific Research Labs., Seattle Wash. Mathematics Research Lab.
**MOMENTS OF INERTIA AND GRAVITY FIELD OF THE MOON Mathematical Note No. 362**
C. L. Goudas Aug. 1964 84 p refs
(DI-82-0368; AD-606233)

The surface harmonics derived from an analysis of the data produced by Schrutka–Rechtenstamm, and Davidson or Brooks are shown to be in agreement with the observed values of the mechanical ellipticity f, and the quantity $\beta$ within the limits of the errors in the harmonics. The correct values of $J_{20}$ and $J_{22}$ are derived with the aid of the latest determinations of f and $\beta$ by Koziel and Jeffreys, respectively. Finally, the potential of the moon is derived as a sum of solid harmonics including terms up to the fourth order, on the assumption that the moon is a homogeneous body. Author

**N65-12445#** Royal Aircraft Establishment, Farnborough (Gt. Brit.)
**MODIFICATIONS TO THE MODEL FOR SATELLITE ORBITS USED IN R. A. E. ORBIT DETERMINATION**
R. H. Gooding Jul. 1964 14 p refs
(RAE-TM-SPACE-41; UDC-521.4)

A description is given of two modifications that have recently, and simultaneously, been made to the model for satellite motion based on Merson's theory. The first is an along-track correction for the main perturbation arising from axial asymmetry of the earth's gravitational field, and the second gives an improvement to the relationship between mean anomaly and mean motion. To assist the users of orbital parameters a summary is given of formulas required for computing satellite positions. For a particular set of parameters a short ephemeris is provided that should be useful for checking purposes. Author

**N65-12472*#** California Inst. of Tech., Pasadena.
**[INVESTIGATIONS IN THE AREAS OF COSMIC RAYS, THEORETICAL ASTROPHYSICS, INTERPLANETARY MAGNETIC FIELDS, INFRARED ASTRONOMY, PLANETARY SPECTROSCOPY, AND INSTRUMENT DEVELOPMENT] Semiannual Status Report, 1 Apr.–1 Oct. 1964**
H. V. Neher et al [1964] 13 p
(Grant NsG-426)
(NASA-CR-59727) OTS Prices: HC $1.00/MF $0.50

The following topics are discussed: "Cosmic rays"—ionization chambers for Mariner C were completed, and a new electronic scanning system accommodating up to 8 chambers was built; "Theoretical Astrophysics"—a computational survey of pulsation in models of RR Lyrae stars was completed; "Interplanetary Magnetic Fields"; "Infrared Astronomy"—a systematic sky survey for sources emitting radiation between 2$\mu$ to 2.5$\mu$ was started; "Planetary Spectroscopy"—the various molecular bands of $CH_4$ and $NH_3$ over the disk of planets Jupiter and Saturn were studied, and the development of a high spectral resolution system for measuring the $CO_2$ band in Mars was continued; and "Instrument Development"—several components of the auxiliary instrumentation for a 200-inch telescope were developed. G.G.

**N65-12496*#** Kansas U., Lawrence. Center for Research in Engineering Science
**ROTATIONAL MOTIONS OF SATELLITES IN A RADIAL GRAVITY FIELD**
Kurt Magnus Jun. 1963 43 p refs
(Grant NsG-298-62)
(NASA-CR-59746) OTS Prices: HC $2.00/MF $0.50

Approximate equations for the motion of satellites of arbitrary shapes are presented, under the assumption that the size of the satellite is smaller than the earth. Stable motions were found to be possible for symmetrical satellites with the axis of symmetry tangential to the orbit in the case of oblate bodies; when the axis of symmetry points to the center of the earth, elongated bodies only were found to give steady-state motions in a circular orbit. The transient behavior of disturbed satellites was found to be nearly independent of the size of the satellite. G.G.

**N65-12521#** Boeing Co., Seattle, Wash.
**AN OUTLINE FOR THE SIMULATION OF A MULTIVARIABLE TERMINAL CONTROLLER**
R. L. Yerke [1964] 46 p refs
(D2-90601; AD-449989)

The lambda matrix guidance scheme is applied to the problem of guiding a rocket vehicle about a nominal orbit-transfer trajectory in the presence of errors and disturbances that are not included in the mathematical model of the physical system. Initially, it is to be applied to the problem of guiding about two-body interplanetary trajectories where thrust is applied for significant periods of time. The trajectories are flown with constant, finite-magnitude thrust, alternated with coasting periods, or in some cases, continuous thrust. The thrust cutoff and start-up times, as well as thrust direction, are considered to be control variables, and the guidance scheme is modified to handle

them. A mission simulation program is outlined in which various disturbances and errors are introduced in order to study the accuracy and limitations of this guidance approach. The equations of motion are presented, along with their associated quantities to be used in the guidance program. Author

**N65-12571#** Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex. Environmental Sciences Directorate
**SIX DEGREE OF FREEDOM DIGITAL SIMULATION MODEL FOR UNGUIDED FIN-STABILIZED ROCKETS**
Louis D. Duncan and Ronald J. Ensey Nov. 1964 25 p refs
(ERDA-196; AD-452106)

A six-degree-of-freedom model for digital simulation of the trajectory of an unguided, fin-stabilized rocket is developed. A derivation of the equations and an explanation of the coordinate systems are presented. The development assumes that the trajectory will be over a rotating planet with a variable atmosphere. A space-variable, three-dimensional wind vector is assumed. The equations of motion are derived from Newton's laws of motion. The aerodynamic forces and moments are based on the theory of stability derivatives and the assumption of linear aerodynamics. The body axes are assumed to be principal axes of inertia. Author

**N65-12609*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**PHOTOELECTRIC uvby AND Hβ PHOTOMETRY OF MAGNETIC AND OTHER PECULIAR AND METALLIC-LINE A STARS**
Robert C. Cameron Nov. 1964 14 p refs Submitted for Publication
(NASA-TM-X-55111; X-641-64-347) OTS Prices: HC $1.00/MF $0.50

About 300 peculiar and 100 Am (metallic line) stars were investigated by intermediate band uvby and narrow-band Hβ photometry. Using the Balmer discontinuity maximum as the hot and cool dividing line, observations of hot, peculiar, magnetic and broad-lined Babcock stars are summarized in a color-vs. metal-index diagram. A crude criterion is considered evident from the diagram: Any star found to lie below the boxed region (containing nonpeculiar stars of luminosity classes III to V) can be identified as a peculiar star without any knowledge of its spectrum. It is also evident from the diagram that there is a preponderance of magnetic stars among those with a metal index ($m_1$) = 0.21. More complex discovery criteria are also established for metallic-line and cool peculiar A stars. Observations of peculiar B and A stars are discussed in relation to various theories concerning rotational velocity (V), and a serious objection is raised concerning the application of the inverse $m_1$–V correlation to the peculiar stars. M.P.G.

**N65-12634#** RAND Corp., Santa Monica, Calif.
**THE APPLICATION OF THE KALMAN FILTER TO SOME ASTRODYNAMICAL PROBLEMS**
F. T. Smith Sep. 1964 43 p refs
(Contract AF 49(638)-700)
(RM-4277-PR; AD-606248) OTS: $2.00

This memorandum applies dynamic programing to the derivation of the computational equations for a Kalman filter. The problem of using a set of ill conditioned observations is considered. For example, when observations of a satellite taken from a single ground station are spaced too close together in time, the accuracy of the determination of the satellite's orbital parameters is poor. Such a set of observations is said to be ill conditioned. The general set of computational equations derived is interpreted in terms of an orbit determination problem, an orbit correction process and a satellite rendezvous problem. Author

**N65-12728*#** Geophysics Corp. of America, Bedford, Mass.
**PLANETARY METEOROLOGY Quarterly Progress Report No. 2, 20 Jul.–19 Oct. 1964**
[1964] 34 p refs
(Contract NASw-975)
(NASA-CR-59695) OTS Prices: HC $2.00/MF $0.50

A model was developed for computing the radiative equilibrium temperature distribution of the entire atmosphere of a planet, such as Venus, that is completely covered by clouds. Two theories for estimating the circulation characteristics of Venus are presented: a model for estimating the average horizontal velocity in the Venusian atmosphere and for computing the mean wind velocity, and a model for determining the circulation pattern of the Venusian atmosphere. Also described are the development of a nongrey radiative transfer model to compute the radiative equilibrium temperature distribution of the Jupiter atmosphere, and the problem of estimating the maximum wind velocity near the Martian surface. G.G.

**N65-12777#** Space Technology Labs., Inc., Redondo Beach, Calif.
**ELECTRONIC SYSTEMS DIVISION PRECISION ORBIT DETERMINATION PROGRAM Third Quarterly Report (Final)**
Bedford, Mass., AFSC, Electron. Systems Div., 15 Apr. 1964 32 p
(Contract AF 19(628)-594)
(STL-8497-6070-RU000; ESD-TDR-64-452; AD-607053) OTS: $2.00

The equations of motion for long periods of time were integrated by the ESPOD subroutine and compared with the results of reference orbits. The reference orbits were calculated by means of analytical formulas for the two-body problem. A comparison between the ESPOD integration subroutine and another subroutine currently in use in other tracking programs is included. G.G.

**N65-12788*#** Ohio State U. Research Foundation, Columbus.
**LOOK ANGLES FOR A CELESTIAL BODY**
S. Zolnay 6 Oct. 1964 31 p refs
(Grant NsG-213-61)
(NASA-CR-59783; Rept.-1388-15) OTS Prices: HC $2.00/MF $0.50

This report presents and solves the problem of computing look angles for a celestial body. The astronomical triangle and its solution is presented and applied to look-angle calculations. Specific examples of computing the position of the sun, the moon, and Polaris by means of trigonometric formulas, tabulated values, and a computer program are given. The accuracy of the computer output is shown to exceed greatly the pointing accuracy required for pencil-beam microwave antennas. Explanations of horizontal parallax and the equation of time are also given. Practical applications of aligning and dynamic checking of tracking accuracy of a microwave antenna are presented. Author

**N65-12790#** Library of Congress, Washington, D.C. Aerospace Technology Div.
**TRACKING OF MISSILES AND SPACE VEHICLES. COMPILATION OF ABSTRACTS**

13 Nov. 1964 52 p refs
(ATD-P-64-62)

Articles contained in Soviet open literature published during the second half of 1963 are included in this compilation of abstracts on the following topics: ion clouds and ionospheric perturbations; reflection of electromagnetic waves from the moon, sun, planets, or artificial satellites; and radio astronomy (radio emission, antennas, and quantum molecular oscillators). M.P.G.

**N65-12819#** Royal Aircraft Establishment, Farnborough (Gt. Brit.)
**DETERMINATION OF THE ORBITS AND CALCULATION OF THE EPHEMERIDES OF ARTIFICIAL EARTH SATELLITES [OPREDELENIE ORBIT I VYCHISLENIE EFEMERID ISKUSSTVENNYKH SPUTNIKOV ZEMLI]**
G. A. Chebotarev, E. N. Makarova, and A. S. Sochilina London, Min. of Aviation, Oct. 1964 34 p refs Transl. into ENGLISH from Obserwacje Sztucznych Satelitow Ziemi (Poland), no. 2, 1963 p 64–79
(RAE-Trans-1078)

Two methods for determining an initial satellite orbit are given: Bazhenov's modification of Gauss' method, and the Laplace method as developed by Kovalevsky and Barbier. A procedure for refining the orbit is described, taking into account the first-order perturbations due to the oblateness of the earth and the usual parametric procedure for atmospheric drag. Included are some formulas required during the calculation of the ephemerides of a satellite. Author

**N65-12825#** Joint Publications Research Service, Washington, D.C.
**THE DEVELOPMENT OF RADAR STUDIES OF CELESTIAL BODIES**
N. St. Kalitsin 18 Dec. 1964 6 p Transl. into ENGLISH from Rabotnichesko Delo (Sofia), 13 Nov. 1964 p 3
(JPRS-27917) OTS: $1.00

The principle of radar as a distance-measuring instrument between the earth and celestial bodies is discussed. Since one-way radio waves are weakened inversely proportional to the square of the travel distance, in the case of a radar echo the energy of the received echo signal is considered inversely proportional to the fourth power of the distance. New powerful radiotelescopes and the application of quantum amplifiers have made is possible to study the Moon, Venus, Mars, and Mercury and to obtain a more precise value for the astronomical unit. G.G.

**N65-12841*#** National Aeronautics and Space Administration, Washington, D.C.
**SPACE EXPLORATION HIGHLIGHTS NASA ACTIVITIES IN 1964 News Release No. 64-321**
24 Dec. 1964 10 p Available from the Scientific and Technical Information Division

Sources at NASA present their space exploration activities during the year 1964. Discussed are the Ranger VII moonflight, the preparations for the Apollo moon landing, the Nimbus weather satellites, and other general activities. G.G.

**N65-12898#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering
**DETERMINATION OF ORBITS USING OPTICAL MEANS**
Algimantas John Ciplickas (M.S. Thesis) Aug. 1964 78 p refs
(GA/EE/64-2; AD-607041)

A method was developed to determine the orbit of an uncooperative satellite from an observer satellite of known orbit by using optical means. Using the method of Gauss, a set of equations was developed for satellites around the earth. The optical instrument is a simple telescope that is mounted on an inertial platform and reads the right ascension and declination angles. An error analysis was performed on these equations, and a computer program was set up. The input data that were used produced unsatisfactory results and were attributed to program error. Author

**N65-12977#** Naval Research Lab., Washington, D.C.
**THE LUNAR OCCULTATION OF X-RAY EMISSION FROM THE CRAB NEBULA**
S. Bowyer, E. T. Byram, T. A. Chubb, and H. Friedman *In its* Rept. of NRL Progress Aug. 1964 p 1–3 ref (See N65-12976 03-34)

The discovery of a strong X-ray source in the Crab Nebula a year ago led to the hypothesis that a neutron star could be the remnant of a supernova explosion observed in this region in the 11th century. If such a star were the X-ray source, rocket-borne instruments would detect a point rather than a diffuse source. During a lunar eclipse of the Crab, a rocket bearing X-ray detectors was sent up to see if there was a sharp break in the signal at some point during the eclipse. Since the signal faded out gradually, the source is now believed to be a cloud of very hot gas rather than a star. Author

**N65-13012#** Army Missile Command, Huntsville, Ala. Redstone Scientific Information Center
**COLOR EXCESSES IN SIX LUNAR CRATERS ACCORDING TO ELECTROPHOTOMETRIC OBSERVATIONS**
K. I. Kozlova and Yu. V. Glagolevskii 23 Oct. 1964 5 p refs Transl. into ENGLISH from Astron. Tsirkuliar (Kazan), no. 198, 1958 p 1–2
(RSIC-313; AD-608538)

Observations were conducted on August 31 and September 1, 26, 27, 28, and 29, 1958. Photometry was performed on the bottoms of six craters through two light filters, yellow and blue. Crater Manillius was used as the base for comparison. All the bottoms of craters observed were compared with it. A color excess CE was determined for each crater in its relation to the base Manillius. The results of measurements on Copernicus, Plato, Plinius, Kepler, Tycho, and Menelaus are presented. P.V.E.

**N65-13093#** International Geophysical Year World Data Center A, Boulder, Colo.
**NORMALIZED SOLAR FLARE DATA, JULY 1955–JUNE 1957 IGY Solar Activity Report Series No. 29**
Constance S. Warwick 16 Nov. 1964 121 p

The flare importances were corrected by varying amounts, the various reports were grouped together, and average values were computed for times of beginning, maximum, and end, as well as for position and importance. Corrected average values of flare area were not derived from these fragmentary early data. D.E.W.

**N65-13122#** Copenhagen U. (Denmark). Astronomical Observatory
**PUBLICATIONS AND MINOR COMMUNICATIONS OF THE COPENHAGEN OBSERVATORY, NO. 177 [PUBLIKATIONER OG MINDRE MEDDELELSER FRA KOBENHAVNS OBSERVATORIUM, NR. 177]**
1963 24 p refs

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3. PHOTOELECTRIC OBSERVATIONS OF VW CEPHEI K. Gyldenkerne, J. E. Jaeger, and K. T. Johansen p 15-24 refs (See N65-13125 03-30)

**N65-13123#** Copenhagen U. (Denmark). Astronomical Observatory.

**PHOTOELECTRIC THREE-DIMENSIONAL SPECTRAL CLASSIFICATION OF G AND K STARS**

Kjeld Gyldenkerne *In its* Publ. and Minor Commun. of the Copenhagen Obs., No. 177 1963 p 3–5 refs (See N65-13122 03-30) Repr. from Astrophys. J., v. 134, no. 2, Sep. 1961 p 657–659

Photoelectric measurements of m for about 250 bright G and K stars were carried out by means of a two-color photometer attached to the twenty-inch telescope of the Brorfield Observatory. Measurements for determination of a K-line index k, a cyanogen index n, and a G-band index g, were carried out previously for the same stars. A luminosity parameter and a chemical composition parameter based on the observational material are established, and the possibility of their use as classification criteria is discussed. D.S.G.

**N65-13124#** Copenhagen U. (Denmark). Astronomical Observatory.

**PHOTOELECTRIC OBSERVATIONS OF BETA LYRAE**

K. Gyldenkerne and J. E. Jaeger *In its* Publ. and Minor Commun. of the Copenhagen Obs., No. 177 1963 p 7–14 refs (See N65-13122 03-30)

Photoelectric observations were carried out at the Brorfield Observatory using a photometer attached to the 10-inch reflecting telescope, a photomultiplier of the EMI 5060 type, and color filters of the Johnson B and V types. The comparison stars were HR 6997 (primary) and 9 Lyr (secondary). The results are presented in tabular form: the magnitude difference between the two comparison stars, corrected for differential extinction, is given for both colors in the first table, and the magnitude differences of $\beta$ Lyr – HR 6997 and $\beta$ Lyr – 9 Lyr as well as the B and V values are given in Table II. D.S.G.

**N65-13125#** Copenhagen U. (Denmark). Astronomical Observatory.

**PHOTOELECTRIC OBSERVATIONS OF VW CEPHEI**

K. Gyldenkerne, J. E. Jaeger, and Karen T. Johansen *In its* Publ. and Minor Commun. of the Copenhagen Obs., No. 177 1963 p 15–24 refs (See N65-13122 03-30)

Photoelectric observations were carried out at the Brorfield Observatory using a conventional photometer attached to the 10-inch telescope. In order to obsesve quickly and cover the light curve with as many points as possible, the observations were carried out without filters. The two stars BD + 74° 889 and BD + 75° 726 were used for comparison, and these stars and the variable were observed alternately with a measuring time per star of about 30 to 40 sec. The corrected magnitude differences, $m_c - m_v$ (comparison minus variable), are given in the accompanying table. D.S.G.

**N65-13137#** Observatorio Astrofisico, Asiago (Italy).

**EBERT-CASSEGRAIN SPECTROGRAPH FOR SOLAR SPECTRUM BETWEEN 4000A AND 5000A**

M. Rigutti and R. Falciani 31 Jul. 1964 47 p ref

(Contract AF 61(514)-1050)

(AFCRL-64-752; AD-449696)

A solar spectrograph is described in detail. The new instrument, called Ebert–Cassegrain because of its particular mounting, has a focal length of 8000 mm with a real total length of 2900 mm and is equiped both photographically and photoelectrically. At present it has been used to set up an atlas of the solar spectrum between $\lambda$ 4000 and $\lambda$ 5000 Å. The atlas is presented as a photographic recording divided into two sections; the reproductions of the plates, and of the microphotograms obtained from the same plates. Besides, a part of the atlas has been recorded directly through the photoelectric device. Author

**N65-13143*#** Esso Research and Engineering Co., Linden, N.J. Chemicals Research Div.

**DEVELOPMENT OF HYDROCARBON ANALYSES AS A MEANS OF DETECTING LIFE IN SPACE Quarterly Report**

W. G. Meinschein 1 Oct. 1964 16 p refs

(Contract NASw-508)

(NASA-CR-59837) OTS Prices: HC $1.00/MF $0.50

Crude oil, pristane, phytane, sterane-type and optically active alkanes, prophyrins and microfossils have been found in the Nonesuch shale of Precambrian age in northern Michigan. Paleobiochemical methods have been applied to increase the information that may be acquired by the analyses of these carbonaceous materials. Analyses of the alkanes from the Nonesuch formation are discussed in detail and illustrate how chemical fossils may be used to study the metabolisms of former organisms. The compositions of the alkanes and the presence of porphyrins in this Precambrian deposit suggest that organisms that apparently existed a billion years ago were metabolically similar to living plants. R.L.K.

**N65-13181#** Air Force Inst. of Tech., Wright-Patterson AFB, Ohio. School of Engineering

**A METHOD FOR DETERMINING THE EFFECT OF DYNAMIC ERRORS OF A RADAR SATELLITE TRACKER ON ORBIT PREDICTION**

Thomas Henry Mc Mullen (M.S. Thesis) 26 Aug. 1964 180 p refs

(GA/EE/64-6; AD-607031) OTS: $6.00

This thesis briefly discusses the difficulty of specifying the accuracy of a satellite tracker. Equations are developed as follows: (1) determine azimuth and elevation angle data and fit them to fourth-order time polynomials; (2) compute the orbit parameters from evaluations of these polynomials; and (3) evaluate the response of a selected tracker transfer function to the input of these time polynomials by the method of Laplace transformation. Orbit elements computed from this last evaluation are compared with the previous set to obtain the error in orbit prediction. A FORTRAN II program is presented that performs these computations on the IBM-7094 digital computer. Author

**N65-13197*#** National Aeronautics and Space Administration. Washington, D.C.

**PROBLEMS OF SOLAR ACTIVITY**

B. M. Rubashev Dec. 1964 397 p refs Transl. into ENGLISH of the book "Problemy Solnechnoy Aktivnosti" Moscow, "Nauka" Publishing House, 1964

(NASA-TT-F-244) OTS Prices: HC $7.00/MF $2.00

This study concerning the nature of solar activity was directed toward raising the qualitative level of solar activity forecasting by a change from the empirical–statistical methods to the more promising physicomathematical methods. The material is presented under the following chapter headings: (1) "Cyclic Character of Solar Activity"; (2) "Structure and Dynamics of the Subphotospheric Layers of the Sun"; (3) "Energy Sources of Solar Activity"; (4) "Certain Manifestations of Solar Activity in the Upper Layers of the Earth's Atmosphere"; (5) "Manifestations of Solar Activity in the Lower Layers of the Earth's Atmosphere"; (6) "Manifestations of Solar Activity in the Brightness of Comets and in Planetary Atmospheres." D.S.G.

**N65-13214#** France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

**ECONOMY OF THE TRAJECTORY DURING ATMOSPHERIC EGRESSION OF A SELF-PROPELLED MISSILE [ECONOMIE DE LA TRAVERSEE DE L'ATMOSPHERE PAR UN ENGIN AUTOPROPULSE]**

Pierre Contensou Repr. from Rech. Aeron. (Chatillon-sous-Bagneux), no. 96, Sep.–Oct. 1963 p 3–12 refs In FRENCH; ENGLISH summary Presented at the 3d European Space Symp., Stuttgart, 20–24 May 1963
(ONERA-TP-22(1963))

In this paper a simultaneous optimization of atmospheric egression and of the motor expansion rate is given. By accepting some assumptions idealizing the missile, it is shown that for optimum trajectories, the thrust vector and the velocity vector must be on the same line, and that there is an economical velocity function of altitude but not function of the trajectory slope. The mass decrement, corresponding to the engine consumption, from zero altitude to atmospheric egression is then independent of the egress angle. Formulas are given for some assumptions made concerning the evolution of the combustion pressure. Author

**N65-13245#** Minnesota U., Minneapolis. School of Physics and Astronomy

**EXPERIMENTAL OBSERVATIONS ON THE INTENSITIES OF HELIUM NUCLEI IN THE PRIMARY COSMIC RADIATION**

P. S. Freier, G. D. Greer, J. Valdez, and C. J. Waddington Oct. 1964 14 p refs
(Contract Nonr-710(60))
(CR-72; AD-608345)

The results are presented of 13 separate observations of the characteristics of the helium nuclei in the primary cosmic radiation. These observations were made using photographic nuclear emulsions flown on high-altitude balloons to detect the particles during times ranging from the minimum of solar activity to the maximum. Attention is confined to the presentation of the experimental data. The results are compared with those published previously on the higher charged nuclei in the cosmic radiation. Author

**N65-13251*#** National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, N.Y.

**PHYSICS OF NONTHERMAL RADIO SOURCES**

Stephen P. Maran (Mich. U.) and A. G. W. Cameron, ed. Jun. 1964 159 p refs Proc. of a conf. held at NASA Goddard Inst. for Space Studies, New York, 3–4 Dec. 1962
(NASA-SP-46) GPO Price $0.75; OTS Price MF $1.00

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**N65-13252*#** Manchester U., Macclesfield (Gt. Brit.) Nuffield Radio Astronomy Labs.

**A SURVEY OF THE SPECTRA OF RADIO SOURCES**

R. C. Conway *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 1–17 refs (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

The compilation of the results of observations at different frequencies, ranging from 38 to 3200 Mc/sec, of a number of sources (160) is discussed. The shapes of the various spectra are discussed, along with the spectral characteristics of some of the sources (e.g., supernovae and galaxies). P.V.E.

**N65-13253*#** California Inst. of Tech., Pasadena. Owens Valley Radio Observatory

**BRIGHTNESS DISTRIBUTIONS IN NONTHERMAL RADIO SOURCES**

Alan T. Moffet *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 19–36 refs (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00
(Contract Nonr-220(19))

Presently available information on the brightness distribution of radio sources at wavelengths between 10 cm and 2 m is summarized. Galactic objects considered are large and small supernova remnants; extraglactic sources discussed include normal and radio galaxies. It is concluded that galactic nonthermal sources have more or less circular shapes and appear to have a shell-like structure, with a diameter of ~50 pc. the smaller supernova remnants have diameters of a few parsecs and brightness temperatures of up to $10^5$ °K. Extragalactic sources have brightness temperatures of up to at least $7 \times 10^6$ °K. The predominant type of radio structure in extragalactic sources is that with two components, symmetrically disposed about the parent galaxy at distances of up to 150 kpc. P.V.E.

**N65-13254*#** Commonwealth Scientific and Industrial Research Organization, Sidney (Australia). Div. of Radiophysics
**LINEAR POLARIZATION EFFECTS IN RADIO SOURCES**
J. A. Roberts *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 37–51 refs (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

The measurement of the polarization of discrete radio sources is discussed along with the results of sources observed at three or more wavelengths. Data are presented suggesting that observed Faraday rotation occurs within our galaxy. The distribution of polarization over a source and its relationship to the source structure provide information about the shape of the magnetic field in the source. A map of Centaurus A that shows total intensity, position angle, and degree of polarization for observations made on the source is presented and discussed. P.V.E.

**N65-13255*#** California Inst. of Tech., Pasadena, Calif. Owens Valley Radio Observatory
**POLARIZATION STUDIES OF DISCRETE RADIO SOURCES**
V. Radhakrishnan *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 53–59 (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

The results of measurements made on 27 sources are presented. It is indicated that the polarization is not uniform over some of the sources as was evidenced by an apparent dependence of the measured percentage on the amount of resolution involved. For the Crab Nebula, 3.7% polarization was measured at 10 cm when the source was negligibly resolved, but 6% was recorded when the visibility amplitude was 0.4. A series of observations indicate that in the extragalactic sources Centaurus A, Pictor A, 3C 270, Hercules A, and 3C 353 there is a variation of the plane of polarization over the source dimensions. From the data obtained it is concluded that the absolute value of the rotation measure is strongly dependent on galactic latitude. P.V.E.

**N65-13256*#** Naval Research Lab., Washington, D.C. E. O. Hulburt Center for Space Research
**N.R.L. POLARIZATION RESULTS**
C. H. Mayer *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 61–67 ref (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

Observations of linear and circular polarization made with the 50-ft radio telescope are summarized. The circular polarization measurements were carried out at 3.15 cm, and the linear polarization data were taken at 3.15, 3.47, and 9.45 cm. Attempts to detect linear polarization at 3.15 cm were successful for Taurus A, Cygnus A, and Centarus A. Positive results were obtained at 9.45 cm for Taurus A, Centaurus A, and Cygnus A. Results of preliminary attempts to detect circular polarization at 3.15 cm for several sources are presented. P.V.E.

**N65-13257*#** Manchester U., Macclesfield (Gt. Brit.) Nuffield Radio Astronomy Labs.
**RECENT POLARIZATION WORK AT JODRELL BANK**
R. Conway *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 69–73 (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

Measurements of linear polarization in 10 discrete radio sources, made with a 250-ft telescope, are summarized. The observations were taken at 21 cm, using part of the equipment that was developed for measuring the Zeeman effect in the hydrogen line. The correlation of the data against a number of parameters, and in particular against spectral information, is discussed. Also shown is the distribution of the sources on a plane in which percent polarization is plotted against the quantity $p$ ($p$ is the ratio of extrapolated to observed flux). P.V.E.

**N65-13258*#** Columbia U., New York, N.Y. Columbia Radiation Lab.
**LINEAR POLARIZATION OF DISCRETE RADIO SOURCES BY USE OF A 9.4 cm MASER**
William K. Rose (NRL) *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 75–78 Sponsored by ONR, Army, and AFOSR (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

Described are 9.4-cm polarization measurements of six radio sources: 3C 48, 3C 147, 3C 286, 3C 295, Hercules A, and 3C 433. By measuring the degree of polarization and the position angle of the electric field vector for maximum intensity at more than one frequency, an upper limit can be obtained for the product of the number of electrons/cc in intergalactic space times $H_{||}$, the average component of the intergalactic magnetic field along the line of sight. Using this method, the upper limits obtained for Hercules A and 3C 433 were $\leq 4 \times 10^{-12}$ and $\leq 2 \times 10^{-12}$, respectively. P.V.E.

**N65-13259*#** California Inst. of Tech., Pasadena, Calif. Owens Valley Radio Observatory
**RADIO PROPERTIES OF IDENTIFIED EXTRAGALACTIC SOURCES**
T. A. Matthews *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 79–83 (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

In most identified extragalactic sources, the centroid of the radio emission falls near the position of the optical object, often within one-tenth of the radio diameter. However, there are at least some sources for which the displacement of the radio centroid from the optical is a significant fraction of the radio centroid diameter. Sources having $L < 10^{40}$ erg/sec (L is the radiated power) are all normal spirals or regular galaxies, while those having $L > 10^{40}$ erg/sec are ellipticals or related types of galaxies. The luminosities of these sources range from $10^{40}$ up to nearly $10^{45}$ erg/sec. The average separation of the members of a rich cluster of galaxies is about 100 kiloparsecs. When a radio source is found to occur in a cluster of galaxies, the galaxy with which it is identified is usually found to be the optically brightest, by several magnitudes, and the largest of the cluster members. P.V.E.

**N65-13260*#** California U., Berkeley. Radio Astronomy Lab.
**THE IDENTIFICATION PROBLEM**
R. Minkowski *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 87–94 (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

The problem of finding optical objects that are associated with radio sources is discussed, and the results of an attempt to prepare a list of reliably determined radio source positions are presented. The probable error in the measurement of right ascension and declination obtained by various groups is outlined and discussed. Also discussed is the question of how many radio stars exist. P.V.E.

N65-13261*# California U., San Diego.
**OPTICAL PROPERTIES OF RADIO GALAXIES**
E. M. Burbidge *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 95–110 refs (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

The optical characteristics of the following extragalactic radio sources are briefly discussed: Messier 82; NGC 1068, 7469, 3226-27, 1275, 5128, 1316, 6166, 4782-83, and 750-51; Messier 87; 3C 66, 295, and 310; and NGC 1218. P.V.E.

N65-13262*# Mount Wilson Observatory, Pasadena, Calif.
**OPTICAL SPECTRA OF RADIO GALAXIES**
M. Schmidt (Palomar Obs.) *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 111–118 (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

Classification of the galaxy spectra in terms of emission-line strength is discussed. The spectra of radio galaxies were studied with respect to the strength of emission lines and to observed redshifts. An attempt to find a correlation between the emission strength and any of the other properties of radio sources gave essentially negative results. P.V.E.

N65-13263*# California U., San Diego.
**MECHANISMS OF ENERGY GENERATION IN EXTRA-GALACTIC RADIO SOURCES**
G. R. Burbidge *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 123–132 (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

In reviewing the various theories that have been proposed to account for the origin of the great energies observed in the strong extragalactic radio sources the following subjects are discussed: observations of great energy releases in galaxies; the ratio of energies stored in protons and electrons; time scales of extragalactic radio sources; magnetic fields and the energy in particles; consequences of short time scales; mechanisms of energy generation; and the origin of double sources. P.V.E.

N65-13264*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, N.Y.
**COLLECTIVE STAR FORMATION AS A CONTRIBUTOR TO EXTRAGALACTIC RADIO SOURCES**
A. G. W. Cameron *In its* Phys. of Nonthermal Radio Sources Jun. 1964 p 133–137 (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

The origin of the energetic particles responsible for the nonthermal emission of strong radio sources is related to the occurrence of type II supernovae. A "collective birth theory" is proposed to account for the necessary number of supernovae required to supply the large number of relativistic particles connected with strong radio sources. The rationale behind the collective birth theory is outlined briefly as follows: The life of a massive star is approximately the time required to convert the hydrogen core to helium; since the luminosity of heavy stars is proportional to the mass, the time required to evolve off the Main Sequency is mass-independent, ($\sim 3 \times 10^6$ years); the star then rapidly evolves to the supernova stage, which occurs by the implosion mechanism. The reason why the simultaneous formation of such stars can be expected is outlined. P.V.E.

N65-13265*# London U. (Gt. Brit.) King's Coll.
**ON THE INTERPRETATION OF FARADAY ROTATION EFFECTS ASSOCIATED WITH RADIO SOURCES**
B. J. Burn and D. W. Sciama *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 139–145 refs (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

A preliminary analysis of the data obtained from radio sources showing Faraday rotation effects is presented. The data are expected to yield information on the distribution of free (thermal) electrons and magnetic fields both in the sources themselves and along the line of sight between the source and the observer. Measurements made on the Crab Nebula are discussed in particular. Two possible explanations as to why the polarization of longer wavelengths from extragalactic sources is greater than expected are discussed. P.V.E.

N65-13266*# Cambridge U. (Gt. Brit.) Cavendish Lab.
**A MODEL OF RADIO GALAXIES**
H. van der Laan *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 147–153 refs (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

Observational data relating to the proposed model are briefly reviewed: radio spectra; brightness distributions; angular diameters; polarization; and optical identifications. Since the process producing synchrotron radiation is completed in a time that is short compared to the age of the radio source, the evolutionary phase can be discussed without detailed knowledge of the initiating process. The proposed model is as follows: A relativistic gas, of a certain energy distribution and total energy, expands spherically from an initial volume of, say, galactic dimensions, into the extragalactic medium. The magnetic field of the medium couples the motion of the relativistic gas with that of the medium's thermal gas. If the initial total energy is sufficiently large, then the rate of expansion is initially supermagnetosonic, and a shock front separates the undisturbed medium from the expanding region. P.V.E.

N65-13267*# Columbia U., New York, N.Y.
**DYNAMICS OF MAGNETIC FIELDS IN RADIO SOURCES**
L. Woltjer *In* NASA. Goddard Inst. for Space Studies Phys. of Nonthermal Radio Sources Jun. 1964 p 155–162 (See N65-13251 03-30) GPO Price $0.75; OTS Price MF $1.00

The question of the magnetic fields present in radio sources is discussed from two points of view: radio spectra and Faraday effect. Several suggested models that are based on observations of the two phenomena are discussed and evaluated. It is concluded that the magnetic fields in radio sources could be permanent features of the associated galaxies; such fields would not normally be observable, but if a large amount of energy is released in the form of relativistic electrons, the region of the field will "light up" and become a radio source. P.V.E.

**N65-13273*** New Mexico U., Albuquerque. Engineering Experiment Station

**[EXTENDING THE CONCEPT OF DIFFERENTIAL REFLECTIVITY TO DETERMINE THE ELECTROMAGNETIC PROPERTIES OF THE LUNAR SURFACE] Semiannual Status Report, 1 May–31 Oct. 1964**

Ahmed Erteza, James A. Doran, and Donald H. Lenhert Nov. 1964 10 p ref

(Grant NsG-129-61)

(NASA-CR-59910; EE-117)

The two major areas of extension discussed are the transient solution of electromagnetic scattering, and the effect of the relative velocity between the source and target on the scattered radiation. A short discussion is given in each of the areas of future investigation. Author

**N65-13290#** Army Cold Regions Research and Engineering Lab., Hanover, N.H.

**COMPARISON BETWEEN SNOW-IMBEDDED AND INDUSTRIAL BLACK SPHERULES**

Chester C. Langway, Jr. and Ursula B. Marvin Oct. 1964 22 p refs

(CRREL-Res. Rept.-154; AD-451668)

The chemical and physical properties of black spherules collected from shallow firn and deep ice layers on the Greenland ice sheet are compared with industrial spherules (weld spatter). Morphologically, both groups of spherules closely resemble each other. Electron probe microanalyses are compared with X-ray diffraction analyses on both groups of spherules. Chemically most of the Greenland spherules are Fe rich with some Si and traces of Mn. Of the five varieties of industrial spherules examined, four contain Ni, some up to 50%; one variety contains no Ni and is chemically similar to the Greenland spherules. Density measurements show the Greenland spherules range between 4.2 and 5.9 g/cm$^3$ and that the industrial spherules studied range between 5.2 and 8.7 g/cm$^3$. Author

**N65-13342#** Joint Publications Research Service, Washington, D.C.

**STUDIES AND CONFERENCES ON ASTROPHYSICS AND GEOPHYSICS**

Ye. P. Fedorov et al 7 Dec. 1964 47 p Transl. into ENGLISH of articles from Vestn. Akad. Nauk SSSR (Moscow), no. 9, Sep. 1964 p 50–57, 62–67, 88–89, 112–121

(JPRS-27720; TT-64-51882) OTS: $2.00

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# 31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

**N65-12476#** North American Aviation, Inc., Los Angeles, Calif.

**ESTIMATED PERFORMANCE REPORT FOR THE ADVANCED X-15A-2 AIRPLANE WITH ONE YLR-99-RM-1 ENGINE, NAA MODEL NO. NA-240-2, APRIL–JUNE 1964**

Arthur F. Tweedie 9 Jul. 1964 70 p

(Contract AF 33(657)-6506)

(NA-64-574; AD-452641)

The pertinent exit and reentry performance of the advanced X-15A-2 is presented. The estimated maximum velocity for the overweight configuration is 8280 ft/sec, while in the probable flight configuration a maximum velocity of 7850 ft/sec can be achieved. Author

**N65-12579#** Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex. Inter-Range Instrumentation Group

**METEOROLOGICAL ROCKET NETWORK FIRINGS VOLUME XXXIII Data Report, May 1964 Firings**

Sep. 1964 205 p

(IRIG-109-62; AD-452583)

This report contains the wind and temperature measurements from all successful available Network firings for May, 1964. It also includes the radiosonde observations nearest the time of firing if they are within ±6 hours. The data were derived from 89 rocketsonde observations. D.E.W.

**N65-12604*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**INSTRUMENTATION REPORT ON SPAEROBEE 300A FLIGHT 6.09 GA**

L. C. Castagnola Oct. 1964 42 p

(NASA-TM-X-55108; X-671-64-284) OTS Prices: HC $2.00/MF $0.50

Engineering data on the development of a performance instrumentation system for Spaerobee 300A, Flight 6.09 GA are presented. Methods employed are discussed, in which maximum precision and reliability of the transmitted data are achieved through the use of signal conditioning electronics. All pertinent calibration curves are included. This report illustrates the function and performance of instrumentation and/or telemeter equipment, and does not present an analysis of either scientific data or performance of the vehicle. Author

**N65-12606*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**ENVIRONMENTAL TESTING OF IONOSPHERE EXPLORER SPACECRAFT Final Report**
W. D. Hoggard, II 6 Oct. 1964 30 p refs
(NASA-TM-X-55109; X-320-64-286) OTS Prices: HC $2.00/MF $0.50

This report contains the complete environmental test history of the Explorer XX spacecraft preliminary to launching. A prototype explorer spacecraft, and the No. 1 and No. 2 spacecraft underwent spin and thermal-vacuum testing; their moment of inertia was determined from the spin, pitch, and yaw axes for the proper balancing. After extension of its sounding antennas, the spacecraft No. 1 was designated Explorer XX and was successfully launched. It performed well, and the degradation of its solar cells has been less than was expected. Sufficient telemetry data have been received since launching to consider the mission successful. G.G.

**N65-12612*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**CONVERSION OF A SPACECRAFT DESIGNED FOR MANNED SPACE FLIGHT TO A RECOVERABLE ORBITING ASTRONOMICAL OBSERVATORY**
Windsor L. Sherman Washington, NASA, Dec. 1964 19 p refs
(NASA-TN-D-2535) OTS Prices: HC $1.00/MF $0.50

A preliminary study has been made of the conversion of a spacecraft designed for manned space flight, e.g., the Mercury spacecraft, to a recoverable orbiting astronomical observatory. The recoverable observatory can be instrumented to perform a wide range of astronomical observations. The optical equipment used for this study consists of a 76-cm cassegrainian telescope with two secondary mirrors, one for narrow-field and one for wide-field observations. The particular conversion of a spacecraft discussed in this paper is for high-resolution photography and photometric studies of discrete objects and of the interstellar and intergalactic background. Data would be recorded by six cameras that would cover the electromagnetic spectrum from 1220 Å to 11 000 Å. The results, which are preliminary in nature, indicate that the conversion is feasible and that a worthwhile contribution could be made to astronomy. An information gain up to a factor of 10 over telemeter data recovery systems may be obtained provided the fine control system can hold drift to less than the 0.08 sec of arc during any exposure. Author

**N65-12631*#** National Aeronautics and Space Administration. Washington, D.C.
**SECOND UNMANNED GEMINI LAUNCH SET FOR DECEMBER 7 News Release No. 64-296**
4 Dec. 1964 31 p Part of Press Kit for Unmanned Gemini (Gt-2)
Available from the Scientific and Technical Information Division

NASA announced the launching of a Gemini spacecraft on a suborbital flight to take place after December 1964. This flight is to last about 20 minutes and is to take place at an altitude of about 106 miles. The overall program containing the test objectives, first and secondary mission objectives, and all other mission parameters is presented. G.G.

**N65-12655*#** National Aeronautics and Space Administration. Washington, D.C.
**APOLLO SPACECRAFT TO TEST ESCAPE SYSTEM IN WHITE SANDS TEST News Release No. 64-299**
6 Dec. 1964 11 p
Available from the Scientific and Technical Information Division

According to information received from NASA, an Apollo spacecraft will be flight tested after December 8, 1964 at the White Sands Missile Range. The major objective of the flight is to demonstrate the Apollo launch escape system under simulated catastrophic launch-vehicle failure at about 31 000 feet, at which the spacecraft is under maximum aerodynamic pressure. A detailed test sequence is presented. G.G.

**N65-12679#** National Research Council of Canada, Ottawa. Radio and Electrical Engineering Div.
**JANUARY 1964 SOUNDING ROCKET LAUNCHINGS AT CHURCHILL RESEARCH RANGE: ROCKETS AA-II-25, AA-II-41, AND AD-II-42**
F. V. Cairns, L. G. Cox, J. H. Craven, S. G. Jones, D. O'Hara et al Jun. 1964 91 p
(ERB-679)

Three Black Brant II A rockets, each containing a number of experiments for the investigation of upper atmospheric phenomena associated with the aurora, were launched with varying degrees of overall success. Two of the rockets failed to reach the desired altitudes owing to vehicle malfunction, possibly caused by an encounter with high wind shear. This report deals with engineering aspects of the payloads and the launchings. Only the engineering data obtained during the flights are presented and discussed. However, a brief description of the experiments and a preliminary assessment of experimental package performance are included. Author

**N65-12836*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**SATELLITE SITUATION REPORT, VOLUME 4, NUMBER 20**
31 Oct. 1964 15 p
(NASA-TM-54891; X-533-63-1) OTS Prices: HC $1.00/MF $0.50

Satellite orbital data computed and compiled by the Goddard Space Flight Center, by NORAD, and by the Smithsonian Astrophysical Observatory are presented. The data are arranged in tables of objects in orbit and of objects that decayed during October 1964. The tables give the code names and the designations and catalogue numbers of the objects, their source countries, launch dates, nodal periods, inclinations, apogees, perigees, and transmitting frequencies. D.E.W.

**N65-12842*#** National Aeronautics and Space Administration, Washington, D.C.
**ITALIAN SAN MARCO SATELLITE LAUNCH SET FROM WALLOPS News Release No. 64-301**
7 Dec. 1964 15 p Available from the Scientific and Technical Information Div.

The Italian Commission for Space Research and NASA present the overall program and a description of the first San Marco satellite to be launched after December 11, 1964. The four-stage solid-propellant Scout rocket will be used to serve as a training exercise for the Italian launch crew in preparation for a sea platform operation, to provide air density measurements, and to observe ionospheric characteristics that are related with long-range radio transmissions. G.G.

**N65-12895#** Lincoln Lab., Mass. Inst. of Tech., Lexington.
**THE LINCOLN EXPERIMENTAL SATELLITE (LES) Group Report, 1964–55**

D. C. Mac Lellan, H. Sherman, and P. Waldron 14 Oct. 1964 24 p
(Contract AF 19(628)-500)
(ESD-TDR-64-559; AD-449485)

A description of and a launch program for all the communications satellites and their specific functions for research in space communications are presented. Considered are the specifications for each satellite subsystem, telemetry performance, and an orbit that permits one or more hours of good visibility. All satellites will be put into orbit as "piggybacks" on Titan III launches. G.G.

**N65-13008#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**THE TWINNED SPACE FLIGHTS OF VOSTOK-5 AND VOSTOK-6**
Peter Hedervari 15 Oct. 1964 9 p Transl. into ENGLISH from Repules (Budapest), no. 8, 1963 p 14–15
(FTD-TT-64-672/1+2+3+4; AD-608152)

A brief discussion is presented of the flights of Vostok-5 and Vostok-6. The problem of the physical–meteorological conditions prevailing at the orbital height of the Vostoks is outlined, and methods and results of studying the radiation to be encountered by the spaceships are discussed. P.V.E.

**N65-13220*** Northrop Space Labs., Huntsville, Ala. Space Systems Section
**APOLLO EXPERIMENTS SUPPORT ON PRELIMINARY ESTIMATE OF DEVELOPMENT COSTS AND SCHEDULE FOR MOLAB Task Report**
T. M. Mc Coy and J. A. Young Huntsville, Ala., NASA. Marshall Space Flight Center, Dec. 1964 78 p refs
(Contract NAS8-11096)
(NASA-CR-61028) OTS Prices: HC $3.00/MF $0.75

The AES–MOLAB Development Project was estimated to cost $291 660 000 based upon certain assumptions and a preliminary schedule. The confidence level in the total development cost, if the assumptions are valid, is minus 15%, plus 30% of the quoted figure. For comparison, it was guess-estimated that the operational phase of AES will cost at least $300 000 000 additionally. Costs were estimated using a matrix type format of hardware end items against project functions. Costs were accrued starting at the major component level and accumulated up through the manufacture and test of complete MOLAB prototypes. Author

**N65-13279*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**RANGER VII FLIGHT PATH AND ITS DETERMINATION FROM TRACKING DATA**
W. R. Wollenhaupt, D. W. Trask, W. L. Sjogren, E. G. Piaggi, D. W. Curkendall et al 15 Dec. 1964 207 p refs
(Contract NAS7-100)
(NASA-CR-59901; JPL-TR-32-694) OTS Prices: HC $6.00/MF $1.25

This report describes the current best estimate of the Ranger VII spacecraft flight path and the way in which it was determined. Tracking of the spacecraft was virtually continuous from injection to lunar impact. Dramatic TV photos of the lunar surface were received during the last 17 min before impacting the moon, in what was later to be named the lunar "Mare Cognitum." This event marked the first time that man has succeeded in obtaining closeup photographs of the front side of the Moon. Postflight analysis of the tracking data resulted in valuable determinations of the masses of the earth and the moon, tracking station locations, lunar ephemeris scale factor, and lunar radius to the Ranger VII impact point, to within 0.4 km. Author

**N65-13280*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
**RANGER VII: MISSION DESCRIPTION AND PERFORMANCE, PART I**
H. M. Schurmeier 15 Dec. 1964 98 p refs
(Contract NAS7-100)
(NASA-CR-59904; JPL-TR-32-700) OTS Prices: HC $3.00/MF $0.75

This paper is a technical description and an evaluation of the performance of the various systems and other elements comprising the Ranger project. It constitutes part of the formal report of the Ranger VII mission, the second in the Block III series, whose flight phase lasted from July 28 to July 31, 1964. Sections included cover the launch preparations and operations, the launch vehicle system, the spacecraft system, the deep space network system, the space-flight operations system, the flight path, and preflight calibration and data enhancement. Appendices summarize Ranger VII spacecraft flight events, the redesign following Ranger VI, and Ranger spacecraft configuration and interfaces. D.E.W.

# 32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

**N65-12342#** Aeronautical Research Labs., Melbourne (Australia).
**AERODYNAMIC INVESTIGATION OF THE WIND LOADS ON A CYLINDRICAL LIGHTHOUSE**
W. H. Melbourne Aug. 1963 32 p refs
(ARL/Aero-224)

This report describes the investigation of a lighthouse design to determine the stability and maximum stress at the base due to steady and oscillatory aerodynamic loads. In connection with the work, a survey of available information on dynamic wind loads on cylindrical structures, particularly chimney stacks, was made. An interesting feature of the work is the evidence of an oscillatory mode with the same frequency as the vortex shedding from the cylinder; this appears to involve the first harmonic superimposed on the fundamental frequency of the cylinder. Particular attention has been given to the problem of dynamic scaling of the wind-tunnel model. This is relevant to similar structures, such as chimney stacks. The lighthouse is nominally a 100-ft-high by 3-ft-diameter steel cylinder, fabricated in four sections butt welded together, and designed to withstand steady winds of 130 mph (i.e., 190 fps). No aerolian instability was approached, but methods of reducing the stress due to oscillatory loads without increasing the drag were investigated. A configuration with long slots in the cylinder wall was recommended. Slotting the cylinder halved the oscillatory stresses at speeds up to 100 fps, but this had very little effect at high speeds. No ovaling instability was observed. Author

N65-12430# Joint Publications Research Service, Washington, D.C.
**RESEARCH IN THE MECHANICS OF DEFORMABLE SOLIDS IN THE LAST 20 YEARS**
P. P. Teodorescu 11 Dec. 1964 11 p Transl. into ENGLISH from Gaz. Mat. (Bucharest), v. 69, no. 8, Aug. 1964 p 291–297
(JPRS-27814; TT-64-51928) OTS: $1.00

This paper presents a summary of all mathematical studies on deformable solids that were made in Rumania during the last 20 years. The construction of the solids was calculated by using analytical methods of materials resistance and construction statics. G.G.

N65-12449*# Naval Research Lab., Washington, D.C.
**FRACTURE TESTING OF WELDMENTS**
J. A. Kies, H. L. Smith, H. E. Romine, and H. Bernstein Washington, NASA, Dec. 1964 58 p refs
(NASA-CR-140) OTS Prices: HC $1.50/MF $0.75

A new and improved apparatus has been designed and built for three-point loading of bend bars. A new formula for $K_{Ic}$ independent of Young's modulus has been derived that fits experimental calibrations and calculations by B. Gross with satisfactory accuracy. A formula is provided by which the requirements for specimen size and notch depth can be calculated for measuring $K_{Ic}$ for a given yield strength of material. A number of comparisons are shown for the effect of rolling direction on $K_{Ic}$ for base plate and for several different kinds of welding. The effect of notch position on $K_{Ic}$ is shown. The slow bend test has advantages of adaptability and simplicity for the purpose at hand. It seems noteworthy that the effect of directionality on $K_{Ic}$ in the base plate is in the same direction but magnified in tests of the welds in the 250-ksi yield strength grade. For some welding procedures the $K_{Ic}$ for some positions in welds was better than for the base plate with no deficiency of hardness. Significance tests were applied to the differences between average values of $K_{Ic}$. From the $K_{Ic}$ numbers listed one may calculate the largest tolerable surface crack corresponding to a given stress applied. The center of the weld presents the lowest toughness of any position. Author

N65-12469*# United Nuclear Corp., White Plains, N.Y. Development Div.
**MINIMUM WEIGHT SHIELD SYNTHESIS FOR SPACE VEHICLES**
F. R. Nakache, A. D. Krumbein, J. Celnik, and J. Certaine 20 May 1964 127 p refs
(Contract NAS8-5277)
(NASA-CR-59723; UNC-5086) OTS Prices: HC $4.00/MF $1.00

The proton-shield synthesis technique for spherical geometry were extended to include a number of dose constraints, and analytic expressions were derived to calculate doses behind given spherical shields in particular proton environments. The theory of shield optimization for generalized convex enclosures was likewise extended, and calculations were carried out that give shield compositions and layer thicknesses over a wide range of parameters. The secondary neutron portion of the optimization theory was also extended to include new materials and more complex shields. Author

N65-12548# College of Aeronautics, Cranfield (Gt. Brit.)
**OPTIMUM STRUCTURAL DESIGN AND LINEAR PROGRAMMING**
H. S. Y. Chan Sep. 1964 13 p refs
(COA-AERO-175)

The criterion for pin-jointed frame structures to be of minimum weight is formulated. An approximate solution is shown to be obtainable by using the method of linear programing. A three-dimensional example demonstrating such an approach is given and compared with the exact solution. Finally, optimum structures for multiple loading systems are discussed. Author

N65-12556# Stanford U., Calif.
**ROTATIONALLY SYMMETRIC PROBLEMS OF HIGHLY ELASTIC INFLATED THIN MEMBRANES SUBJECTED TO RING LOADS**
Julio Fernandez-Sintes and W. Nachbar Sep. 1964 121 p refs
(Grant DA-ARO(D)31-124-G464)
(SUDAER-209; AROD-3106-4; AD-451185)

A method is derived to solve rotationally symmetric problems of inflated, highly elastic membranes subjected to uniform circumferential line loads. With the assumption that the material of the thin membrane is conservative, initially isotropic, and incompressible, expressions are obtained for the effective coefficients in a linear stress–strain law governing small-strain perturbations from a state of finite strain resulting from inflation of the membrane. Elastic properties of small-strain perturbations from the inflated state are generally orthotropic and depend on the first and second partial derivatives of the strain energy function with respect to the invariants of strain. The problem of the annular indentation by a ring load of a long, inflated, circular, cylindrical membrane is examined. A theoretical solution previously obtained by Hoff and Nachbar for an isotropic stress–strain law is modified to apply to the orthotropic case. Equations for rotationally symmetric problems of finite deformations superposed on a known finite deformation of a thin membrane are derived. Author

N65-12564# Martin Co., Denver, Colo.
**PROGRAM 624A DESIGN LOADS REPORT, CONFIGURATION C, PRELIMINARY ISSUE**
K. Kopp, R. Ikard, and R. Morra Nov. 1964 160 p refs
(Contract AF 04(695)-150)
(SSD-CR-64-197; AD-451423)

Presented is a compilation of all significant flight and ground loads that are anticipated for the 624A Configurations-C flight vehicle. All Configuration-C vehicles of flights 1 through 17 were considered. The applicable configurations consist of the 624A Configuration-C afterbody and the standard cone-cylinder-nose fairing with dummy payload weights of 21 000 lb, 3800 lb, and 800 lb. Flight loads are presented for all critical portions of the Step O flight regime. Ground-loading conditions are generally defined by specification requirements. In the flight-load area, however, considerable searching is necessary to locate the particular wind azimuth, altitude, etc., that produce maximum loads. In addition to maximum combined loads, the individual components of loading from the various sources, such as basic flight-trajectory loads, dispersed loads, gust loads, and buffet loads are presented to show their relative contribution to the total loading. Supporting data, such as mass property data, flight-trajectory data, control-system autopilot gains, and aerodynamics are also provided. Author

N65-12573# Army Electronics Research and Development Activity, White Sands Missile Range, N. Mex.
**PRELAUNCH REAL-TIME IMPACT PREDICTION SYSTEM AND RESEARCH PROGRAM FOR THE ATHENA ROCKET**
Henry Rachele and Louis D. Duncan Nov. 1964 45 p refs
(ERDA-202; AD-451710)

A general description is given of an essentially automatic data collection, transmission, and ballistic calculation system that will be used for prelaunch impact prediction of Athena

rockets fired from Green River, Utah, to White Sands Missile Range, New Mexico. From a ballistic standpoint, the use of an automatic rocket impact predictor and of a high-speed digital computer is emphasized. From a wind standpoint, emphasis is given to the use of a 90-foot wind pole, a 500-foot wind tower, and an automatic pilot-balloon tracking system, since winds near the surface are of special concern. The ballistics equations used in the system are derived and explained. These consist of five equations of motion that describe the position and attitude of the rocket. The wind data-reduction methods used in the automatic rocket impact predictor and digital computer for each part of the wind system are described. Author

**N65-12581#** Aerospace Corp., El Segundo, Calif.
**STABILITY AND RESPONSE OF CYLINDRICAL SHELLS TO MOVING LOADS**
John P. Jones and Pravin G. Bhuta (Space Technol. Labs.) 15 Mar. 1963 30 p refs
(Contract AF 04(695)-169)
(BSD-TDR-63-35; TDR-169(3153-10)TN-1; AD-403001)

The stability of a circular cylindrical shell subjected to a moving ring load with a constant velocity has been examined in detail when both longitudinal and transverse inertia effects are included, using both the Timoshenko and the Flügge equations. Author

**N65-12610*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**ADVANCED ORBITING SOLAR OBSERVATORY DEVELOPMENT TASKS**
2 Dec. 1964 42 p 2nd ed.
(NASA-TM-X-55114; X-623-63-137) OTS Prices: HC $2.00/MF $0.50

This study presents the guidelines for the development and fabrication of an advanced orbiting solar observation system. The detailed test plans with all specifications are presented, and the subsystem requirements are discussed. G.G.

**N65-12613*#** California Inst. of Tech., Pasadena.
**THE EFFECT OF END SLOPE ON THE BUCKLING STRESS OF CYLINDRICAL SHELLS**
C. D. Babcock and E. E. Sechler Washington, NASA, Dec. 1964 14 p refs
(Grant NsG-18-59)
(NASA-TN-D-2537) OTS Prices: HC $1.00/MF $0.50

Seamless cylindrical shells with $R/t \approx 800$ were loaded with a uniform axial load to failure. The radial displacement of the boundary was controlled, and the boundary slope was measured. With these values known, the maximum slope of the shell near the boundary could be calculated. If the maximum slope is plotted against the degradation of buckling stress from the classical value a definite correlation appears. Author

**N65-12621*#** Lockheed Missiles and Space Co., Sunnyvale, Calif.
**INVESTIGATION OF JUNCTURE STRESS FIELDS IN MULTICELLULAR SHELL STRUCTURES**
E. Y. W. Tsui, F. A. Brogan, J. M. Massard, P. Stern, and C. E. Stuhlman Feb. 1964 161 p refs
(Contract NAS8-11079)
(NASA-CR-59767; M-03-63-1) OTS Prices: HC $5.00/MF $1.00

Described are the discontinuity stress fields that arise in thin elastic multicellular shell structures subjected to inertial, pressure, and thermal loading conditions in combination with residual stresses resulting from fabrication and assembly. Since analytic and variational methods were not believed to be suitable for solving such problems, numerical techniques were investigated. The report includes a review of pertinent literature; the derivation of the general shell equations and their specialization to the cone, sphere, cylinder, and plate; a brief discussion of finite difference expressions; and a description of the method of solution. Author

**N65-12622*#** Aerojet-General Corp., Azusa, Calif. Structural Materials Div.
**DESIGN IMPROVEMENTS IN LINERS FOR GLASS-FIBER FILAMENT-WOUND TANKS TO CONTAIN CRYOGENIC FLUIDS Quarterly Report No. 0889-01-1, 1 Jul.–30 Sep. 1964**
R. N. Hanson Oct. 1964 56 p refs
(Contract NAS3-4189)
(NASA-CR-59763) OTS Prices: HC $3.00/MF $0.50

A materials-selection study was conducted to establish material physical properties, and to evaluate them for fabrication and design requirements. A geometric analysis was made to develop equations that define linear stresses and that control pattern geometry. The S and crossing patterns were selected for evaluation in the first series of 8-in.-diam specimen tests that are based on results of the biaxial strain testing. Liners for the first series of test specimens will be fabricated from Type 304 stainless-steel foil, 1100 aluminum foil, and both Mylar and Kel-F laminated to aluminum foil. Both the S and crossing patterns will be fabricated from each of these materials for a total of eight specimens. These specimens will be 8-in.-diam chambers that are fabricated with a Dacron–resin composite of 35% bosses and a length-to-diameter ratio of 1.4. Author

**N65-12661#** Joint Publications Research Service, Washington, D.C.
**ARCHITECTURE IN SPACE**
B. Zayonchkovskiy et al 14 Dec. 1964 21 p Transl. into ENGLISH from Nauka i Zhizn (Moscow), no. 10 Oct. 1964 p 97–104
(JPRS-27816; TT-64-51929) OTS: $1.00

The architecture of circumterrestrial space stations and research laboratories on the moon is discussed. The low force of gravity on the moon, the absence of an atmosphere, and the protection from sharp temperature variations, as well as from meteor impacts, are considered. A lunar underground settlement built of air-impermeable material was found to be most feasible. G.G.

**N65-12678#** College of Aeronautics, Cranfield (Gt. Brit.)
**AN INVESTIGATION OF SURFACE DEFORMATIONS OCCURRING AT THE CONTACT EDGES OF STATICALLY LOADED DISCS**
D. A. Jones and B. R. Reason Sep. 1964 26 p refs
(COA-AERO-164)

An investigation has been carried out, using statically loaded steel and Perspex discs, on elastic displacements occurring at the axial extremities of the Hertzian flat. By employing the technique of photostress, together with optical magnification, it was possible to inspect in detail the disposition of strain around these points. Using a step-grinding technique, a qualitative three-dimensional envelope of surface displacements has been constructed. The effect of these displacements is considered in relation to edge pitting of discs. Author

**N65-12685*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**SOME MEASUREMENTS OF THE DYNAMIC AND STATIC STABILITY OF TWO BLUNT-NOSED, LOW-FINENESS-RATIO BODIES OF REVOLUTION IN FREE FLIGHT AT M-4**

Barbara J. Short and Simon C. Sommer Washington, NASA, Oct. 1959, 28 p refs

(NASA-TM-X-20) OTS Prices: HC $2.00/MF $0.50

(Declassified)

Measurements have been made at a Mach number near 4 of the dynamic and static stability and drag of two blunt-nosed, low-fineness-ratio bodies of revolution in free flight. One model had a parabolic forebody, and the other had a nearly flat front face. The experimentally determined dynamic stability was found to be a function of angle-of-attack. The flat-faced model was dynamically unstable throughout the angle-of-attack range covered, 4° to 16°. The parabolic body was found to be dynamically stable throughout most of the angle-of-attack range covered by the tests but was unstable at the lowest angle, 4°, and neutrally stable at the highest angle, 27°. Modified Newtonian impact theory generally predicted the magnitude of the dynamic stability parameter but not the variation with angle-of-attack. Author

**N65-12693*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**THE STATIC STABILITY CHARACTERISTICS OF SEVERAL PRELIMINARY MODELS OF THE X-15 RESEARCH AIRPLANE AT MACH NUMBERS OF 2.98 and 4.01**

Robert W. Dunning Washington, NASA, Nov. 1959 62 p refs

(NASA-TM-X-166) OTS Prices: HC $3.00/MF $0.75

(Declassified)

An investigation has been conducted in a high-Mach-number jet to determine the static stability characteristics of several preliminary models of the X-15 research airplane. For each model, tests of the complete airplane and various combinations of its components were made at Mach 2.98 and 4.01 and Reynolds numbers from $2 \times 10^6$ to $4 \times 10^6$ based on wing mean aerodynamic chord. Six-component data were obtained through angles-of-attack from −4° to 24° at angles-of-sideslip from −5° to 1°. The results indicate that, in general, the stability characteristics of configuration 3 were satisfactory and that shortening the leading edges of the side fairings and changing the section of the horizontal tail from a modified NACA 66-005 to a wedge section resulted in appreciable longitudinal stability increases. Similarly, increasing the amount and proportion of the ventral tail area and using a wedge section on the upper and lower vertical tail improved the yawing-moment characteristics throughout the angle-of-attack range. Author

**N65-12695*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**SOME EFFECTS OF CONTROL PROFILE AND CONTROL TRAILING-EDGE ANGLE ON THE OSCILLATING HINGE-MOMENT AND FLUTTER CHARACTERISTICS OF FLAP-TYPE CONTROLS AT TRANSONIC SPEEDS**

William C. Moseley, Jr. and Thomas G. Gainer Washington, NASA, Jan. 1960 69 p refs

(NASA-TM-X-170) OTS Prices: HC $3.00/MF $0.75

(Declassified)

Free-oscillation tests were made in a high-speed 7- by 10-foot tunnel to determine some effects of control profile and control trailing-edge angle on the dynamic hinge-moment characteristics of a trailing-edge, flap-type control. The unswept, untapered semispan-wing-control models had aspect ratios of 3 and NACA 65A-series airfoil sections. The essentially full-span control was 30% of the wing chord and was hinged at the 0.765 wing-chord line. Tests at Mach numbers from 0.60 to 1.02 were made for a range of oscillation reduced frequency at an angle-of-attack of 0°. Author

**N65-12696*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**EXPERIMENTAL AND CALCULATED SUPERSONIC FLUTTER CHARACTERISTICS OF MODELS OF THE X-15 HORIZONTAL AND VERTICAL TAILS**

William T. Lautern, Jr. and Robert W. Hess Washington, NASA, Dec. 1959 39 p refs

(NASA-TM-X-176) OTS Prices: HC $2.00/MF $0.50

(Declassified)

A series of tests have been conducted at Mach numbers of 1.64, 2.0, 3.0, and 4.0 to investigate the possibility of flutter on dynamically and elastically scaled models of the all-movable horizontal- and vertical-tail surfaces of the X-15 airplane. No flutter was obtained on the scaled models. Flutter was obtained on four weakened models of the horizontal tail at Mach 1.64, 2.0, and 3.0 and one weakened vertical-tail model at Mach 3.0. The test results and structural information are presented. Also presented are the results of flutter calculations using aerodynamic forces derived from piston theory. The agreement between calculated and experimental flutter speeds is very good at Mach 3.0 for the horizontal tail, but at the lower Mach numbers the agreement is less satisfactory. Author

**N65-12718*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**PRELIMINARY INVESTIGATION OF DYNAMIC LATERAL STABILITY CHARACTERISTICS OF A CONFIGURATION OF THE NORTH AMERICAN X-15 RESEARCH AIRPLANE**

Martin T. Moul Washington, NACA, 3 Dec. 1958 41p refs

(NACA-RM-L56L27) OTS Prices: HC $2.00/MF $0.50

(Declassified)

A preliminary theoretical investigation was made to determine the dynamic lateral stability characteristics of a configuration of the North American X-15 research airplane. Of specific concern were characteristic modes, period and damping, airplane response to yaw and roll controls, ratio of roll to sideslip in the Dutch-roll oscillation, and the roll-coupling problem. Results are presented for a Mach number of 6.86, altitudes of 100 000, 150 000, and 200 000 feet, and angles-of-attack of 0° and 16°. Configuration with speed brakes closed and fully open were investigated, and two intermediate cases, which may represent partially opened speed brakes, were also included. Roll-coupled motions were noted for an altitude of 100 000 feet with either yaw or roll controls operative. Large roll-to-sideslip ratios, rolling sensitivity to yaw inputs, and roll coupling resulting from yaw inputs were noted for an angle-of-attack of 0° and could be alleviated by reducing the effective dihedral $C_{l_\beta}$. Author

**N65-12721*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**THE STATIC AND DYNAMIC-ROTARY STABILITY DERIVATIVES OF A MODEL OF THE X-15 RESEARCH AIRPLANE AT MACH NUMBERS FROM 1.55 TO 3.50**

Phillips J. Tunnell and Eldon A. Latham Washington, NASA, Jan. 1959 47 p refs

(NASA-Memo-12-23-58A) OTS Prices: HC $2.00/MF $0.50

(Declassified)

Presented are the static and dynamic stability derivatives of a 0.09-scale model of the X-15 research airplane as determined by wind-tunnel tests. Tests were conducted at Mach 1.55, 2.00, 2.50, 3.00, and 3.50 at a Reynolds number of $1.5 \times 10^6$, based on the wing mean aerodynamic chord, at

angles-of-attack from −6° to +14°. Measurements were made of the damping-in-pitch, -yaw, and -roll derivatives, the cross derivatives, the static longitudinal and directional derivatives, and the effective dihedral derivative. The complete model was statically stable both longitudinally and directionally. In general, the addition of speed brakes increased the directional stability and the damping in yaw; the higher the Mach number, the greater the increase. The modification of the vertical tail from an 11.5° double-wedge section to a 10° single-wedge section of 5% less area provided an appreciable increase in directional stability and damping in yaw at Mach 2.5, 3.0, and 3.5. Author

**N65-12779#** Lockheed-California Co., Burbank.
**DEVELOPMENT OF A POWER SPECTRAL GUST DESIGN PROCEDURE FOR CIVIL AIRCRAFT Monthly Progress Report, 1–30 Nov. 1964**
F. M. Hoblit 8 Dec. 1964 13 p
(Contract FA-WA-4768)
(MPR-9)

The work accomplished is reported for dynamic analyses of lateral gusts, and for design type loads of reference airplanes. Brief discussions are given of the levels of N(y) and $a_w\eta_d$ necessary to reach the limit of reference airplanes, the parameter variations, and the work performed in a subcontract. D.E.W.

**N65-12798*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**INVESTIGATION OF THE LOADING CHARACTERISTICS OF THE LIFTING SURFACES AND THE SPEED BRAKES OF A 0.067-SCALE MODEL OF THE NORTH AMERICAN X-15 AIRPLANE (CONFIGURATION 3) AT MACH NUMBERS OF 2.29, 2.98, AND 4.65**
H. Norman Silvers, Julia A. Lancaster, and Jane S. Wills. Washington, NASA, Sep. 1960 163 p refs
(NASA-TM-X-301) OTS Prices: HC $5.00/MF $1.00
(Declassified)

A wind-tunnel investigation was made to determine the normal-force, bending-moment, and torsion-moment characteristics on the lifting surfaces and speed brakes of a 0.067-scale model of the North American X-15 airplane (configuration 3). The investigation included the determination of the loading characteristics on the left- and right-wing panels, the left and right horizontal-tail panels, the movable portions of the upper and lower vertical-tail panels, and the upper and lower speed brakes. The investigation was made at Mach 2.29, 2.98, and 4.65 and at several Reynolds numbers, based on the wing mean aerodynamic chord, from approximately $0.5 \times 10^6$ to $4.4 \times 10^6$. The results of this investigation are presented in tabular form without analysis. Author

**N65-12817#** Army Materials Research Agency, Watertown, Mass. Materials Engineering Div.
**SINGLE EDGE CRACKS IN RECTANGULAR TENSILE SHEET**
Oscar L. Bowie and Donald M. Neal May 1964 17 p refs
(AMRA-TR-64-13; AD-603855)

The stress intensity factors for single-edge cracks in rectangular tensile sheet are studied by using a complex variable form of analysis. The results for deep cracks show a considerable increase in the intensity factors as compared to symmetric edge cracks. Accurate numerical values of the stress intensity factors for the appropriate range of parameters are included. Author

**N65-12818#** Royal Aircraft Establishment, Farnborough (Gt. Brit.)
**THE DEVELOPMENT OF VERY FINE CRACKS IN A SOLID BODY [ROZVITOK NAIDRIBNISHIKH TRISHCHIN V TVERDOMU TILI]**
M. Ya. Leonov and V. V. Panasyuk London, Min. of Aviation, Sep. 1964 19 p refs Transl. into ENGLISH from Prikl. Mekhan., Inst. Budivel'noi Mekhan., Akad. Nauk Ukr. RSR (USSR), v. 5, no. 4, 1959 p 391–401
(RAE-Trans-1077)

The possibility of applying the methods of the theory of elasticity to solve problems of the development of very slight cracks in a solid body is described. This possibility is realized by introducing forces of interaction of the edges of slight cracks. The basic equations (4.5) and 4.8) of this problem are given. Proceeding from the physical notion of the change in the interaction between atomic planes with increase in distance, a law of interaction between the edges of slight cracks is selected in the form, 1.5 or 4.1. Applying this law and the basic equations of the problem to an example, it is shown that the presence of a single linear dislocation (slight crack) in an unbounded solid body lowers the theoretical tensile strength of the body by about one-half. Author

**N65-12862#** Southampton U. (Gt. Brit.) Inst. of Sound and Vibration Research
**RESPONSE OF A MULTI-SUPPORTED BEAM TO A RANDOM PRESSURE FIELD**
C. A. Mercer Mar. 1964 72 p refs
(Contract AF 61(052)-504)
(ISAV-Memo-103)

The method of normal modes is applied to the response of a beam of finite length on many simple supports. This is shown to be a reasonable model for vibrations of a skin-stringer structure of greater aspect ratio than two. A short résumé of other work in this field is included. Numerical examples of the response spectra are presented for forms of excitation corresponding to boundary layers and jet noise. The effects of resonance and wavelength coincidence are studied. It is shown that the contribution to the response spectra by the cross products of any two modes may be ignored provided wavelength coincidence does not occur in the frequency range of interest. Author

**N65-12867#** National Aerospace Lab., Tokyo (Japan).
**ON THE VIBRATION ANALYSIS OF AIRCRAFT WINGS**
Tadahiko Kawai, Hideo Izumi, Hayato Togawa, and Yoichi Hayashi 1963 48 p refs In JAPANESE; ENGLISH summary
(NAL-TR-46)

Based on the variational principle, the fundamental equation of lateral torsional vibration of a beam with variable cross section is derived, and the general method of solution of such a beam is proposed. In those equations of motion, the effect of shear deformation as well as that of rotatory inertia on the vibration characteristics of the beam are considered so that the realistic vibration analysis of a wing structure may be possible. Taking a typical jet transport plane as an example, an extensive vibration analysis is made, and results obtained are compared with those of previous investigators. Author

**N65-12868#** National Aerospace Lab., Tokyo (Japan).
**ON THE NATURAL VIBRATION OF PLATE-LIKE WINGS OF VARIABLE THICKNESS**

Taketoshi Hanawa, Shinichi Koshide, Hayato Togawa, and Tadahiko Kawai 1964 36 p refs In JAPANESE; ENGLISH summary
(NAL-TR-60)

An analysis is shown, with some experimental verification, for the vibration frequencies and modes of platelike wings of variable thickness, whose shapes are either parallelograms or trapezoids. Numerical calculations are made for the cases of wings with tapered spans and constant width. Author

**N65-12869#** National Aerospace Lab., Tokyo (Japan).
**NUMERICAL EXAMINATION ON THE FULFILLMENT OF NATURAL BOUNDARY CONDITIONS BY THE APPROXIMATE SOLUTIONS FOR BENDING AND VIBRATION OF THIN ELASTIC PLATES BASED ON THE RAYLEIGH-RITZ'S PROCEDURE (IN CASE OF CANTILEVERED WING PLATES)**
Tadahiko Kawai, Taketoshi Hanawa, Shinichi Koshide, Hayato Togawa, and Kaoru Ochiai 1964 42 p refs In JAPANESE; ENGLISH summary
(NAL-TR-66)

In the direct method of variational calculus, the natural boundary conditions may be satisfied mathematically by the trial function with infinite number of parameters of appropriate choice. In actual calculation, however, the number of parameters in the trial function must be limited and the natural boundary conditions will not be satisfied exactly. Therefore, it is very important to know the relation between the degree of fulfillment of the natural boundary conditions by trial functions and the number of parameters appropriately selected in these test functions. This is a study of the approximate solutions that were obtained in bending or vibration of thin cantilevered wing plates. Besides the numerical examination on the fulfillment of natural boundary conditions, the convergence of approximation solutions is briefly discussed. Author

**N65-12887#** United States Steel Corp., Monroeville, Pa. Applied Research Lab.
**DEVELOPMENT OF A DROP-WEIGHT-BULGE TEST—I**
S. T. Rolfe and L. P. Connor 1 Jul. 1964 19 p ref
(Contract NObs-88540)
(S-13326; AD-604871)

Described is a program to develop a laboratory test in which plate specimens could be 1:1 biaxially strained at relatively high loading rates to produce deformations similar to those observed in the explosion-bulge test plates. Results of extensive experimentation indicate that the deformation distribution observed in explosion-bulge test plates can be simulated in a 1/2-in.-thick plate if a 14-in. test specimen is placed on top of a 9-in.-i.d. anvil and impacted by a 5-1/2-in.-diam hemispherical striker. The striker transmits an energy of 20000 ft-lb to the plate through aluminum pads that distribute the strain throughout the plate bulge. Examination of drop-weight-bulge specimens of a 1/2-in.-thick, 150-ksi yield-strength 5Ni-Cr-Mo-V steel showed that the strain field was uniform throughout a 2-in.-diam polar region. The surface strain in this region was 0.2 in./in., and the thickness reduction was 30%. Author

**N65-13013#** Army Missile Command, Huntsville, Ala. Redstone Scientific Information Center
**POLARIZED LIGHT STRESS INVESTIGATIONS ON TENSILE BAR WITH HOLES AND ON A RIVET HOLE**
A. Hennig 16 Oct. 1964 26 p refs Transl. into ENGLISH from Forsch. Gebiete Ingenieurw. (Düsseldorf), v. 4, no. 2, 1933 p 53–63
(RSIC-315; AD-608384)

The development of stress conditions in a tensile bar with holes and on a rivet hole was determined by photoelastic experiments and analysis. The changes caused by the appearance of larger holes in a tensile bar were determined by the computation of isoclinics for the infinite sheet and recorded for finite relationships. A simple approximation formula was found for the stress increase at the smallest cross section as a function of hole diameter when the hole diameter is less than one-half the width of the bar. A uniform stress condition depending upon the Poisson constant m was found for the rivet hole case, and calculations of the isoclinics and the peak of shear stress proved that the changes related to extreme limiting values of m are negligible. G.G.

**N65-13014#** Army Missile Command, Huntsville, Ala. Redstone Scientific Information Center
**SOME APPLICATIONS OF PHOTOELASTIC MEASUREMENTS**
A. Kammerer 16 Oct. 1964 23 p refs Transl. into ENGLISH from Mem. de la Soc. des Ingr. Civils de France, v. 98, no. 1–3, 1965 p 65–77
(RSIC-316; AD-608539)

The photoelastic determination of the elastic stresses inside a body that is subjugated to known external stresses and forcibly bonded in position at certain points is considered. Two-dimensional elasticity problems of a strictly planar nature were studied, including the hoop effect of a ring, connecting beads of bent parts, the heads of connecting rods, the support of sluice gates and coffer dams, the side of a railroad car, and boiler plates. Also investigated was the nonplanar, two-dimensional elasticity for rail butts, river bridges, and roofing of sheds. Some three-dimensional problems and photoelastic vibration measurements are also presented. G.G.

**N65-13015#** Army Missile Command, Huntsville, Ala. Redstone Scientific Information Center
**THE APPLICATION OF PHOTOELASTICITY TO PERCUSSION STUDY**
Jean Thouvenin 27 Oct. 1964 5 p refs Transl. into ENGLISH from Compt. Rend. Acad. Sci. (Paris), v. 201, no. 1, 1935 p 769–771
(RSIC-319; AD-608369)

A device capable of capturing the complete picture of the stress pattern in a transparent plate in a very small time interval, such as 1/4000 of a second, is reported. The apparatus produces a 4-kc/sec series of sparks, the light from which encounters in sequence a circular polarizer, the model to be studied, a concave mirror with a 1-m radius, a circular analyzer, and an objective that forms the image of the model on the film. The device was used to photograph the formation and propagation of shock waves in a glass plate 120 × 80 × 6 mm that were produced by a weight falling on a knife with a 3-mm cutting edge. D.E.W.

**N65-13019#** Aerospace Corp., El Segundo, Calif. Solid Mechanics Dept.
**ON THE FREE VIBRATION OF A THIN-WALLED CYLINDRICAL SHELL SUBJECTED TO A BENDING MOMENT**
V. I. Weingarten 10 Nov. 1964 31 p refs
(Contract AF 04(695)-269)
(SSD-TDR-64-155; TDR-269(4560-40)-4; AD-608654)

The effect of a bending moment on the free vibrations of a thin-walled cylindrical shell is investigated by means of a modified Donnell equation. An experimental investigation was performed in conjunction with the analysis. The results indicate that as the bending moment increases, some frequency curves increase in magnitude while others decrease; this is contrary to results obtained for symmetric loadings. Author

N65-13036# Polytechnic Inst. of Brooklyn, N.Y.
**PRESSURIZED RING-REINFORCED OVAL CYLINDER. COMPARISON OF THEORY AND DTMB TESTS**
Joseph Kempner, William P. Vafakos, and Neil Nissel Sep. 1963 16 p refs
(Contract Nonr-839(14))
(PIBAL-671; AD-419034)

The cylinder treated is composed of two different skin thicknesses. The theoretical results are obtained by using the local skin thickness of the cylinder in solutions developed for ring-reinforced short oval cylinders of uniform thickness. Good agreement exists between the results of theory and test for all circumferential stresses and for the axial bending stresses, but not for the axial membrane stresses. The solution based upon using the local skin thickness cannot be expected to yield accurate results for these latter stresses. However, these can be shifted toward the test results by applying a simple one-dimensional correction. Author

N65-13089 Midwest Research Inst., Kansas City, Mo.
**A STUDY OF THE EFFECT OF SURFACE FILMS ON FATIGUE FRACTURE Annual Summary Report, 15 Aug. 1963–14 Aug. 1964**
J. C. Grosskrentz and C. Quinton Bowles [1964] 22 p refs
(Contract Nonr-3908(00))
(AD-605851)

The motion and configuration of dislocations near the surface of polycrystalline aluminum, single-crystal aluminum, and polycrystalline gold in relation to their anodic layer thicknesses and the effects of surface films on these parameters were studied. The UHV cyclic straining devices underwent deformation testing under absolute pressure during cyclic binding in a state of vacuum, and a subsequent optical surface observation. It was found that the removal of atmospheric gases suppressed the slip-band formation for both the polycrystalline and the single-crystal-aluminum sample surfaces; areas of fine slip could build up under low cyclic straining. The surface slip was also suppressed by anodic layers in proportion to their thicknesses. In both gold and aluminum the dislocation loops were associated with slip lines in regions of intense slip. Slip step occurred regardless of the presence of an oxide layer and caused a lattice strain around the step. G.G.

N65-13115# Weapons Research Establishment (Australia).
**THE FAILURE PRESSURES OF COMMERCIALLY PURE ALUMINUM SHEARING DISCS UNDER HYDROSTATIC LOADING**
B. E. Furby Jun. 1964 22 p
(WRE-TN-CPD-90)

A study is made of the hydrostatic pressures causing failure of commercially pure aluminum shearing discs in the fully annealed condition. The failure pressure and the ratio of disc thickness to diameter are almost linearly related. For discs taken from any one sheet of material, the failure pressures are within 1% of each other. The failure pressures of discs from any sample may be predicted to within 4%. Author

N65-13215# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.
**STRUCTURAL OPTIMIZATION OF RIB-SANDWICH CYLINDERS SUBJECTED TO EXTERNAL PRESSURE**
J. T. Hofeditz and H. Chao 23 Aug. 1963 72 p refs Appendix B added 27 Oct. 1964
(SM-44579)

Overall instability, local buckling of the skins and ribs, and failure by exceeding allowable compressive strength of the material are considered. Discontinuity stresses induced by the ribs are taken into account. The conclusion is that if discontinuity stresses are ignored, the predicted weight of the structure is in general too low; furthermore, cross-section dimensions can be far from optimum. Although the material is assumed perfectly elastic, a method is outlined for obtaining a first-order approximation for the case of buckling in the inelastic range. Author

N65-13234# Drexel Inst. of Tech., Philadelphia, Pa.
**THE STRONG PLANE SHOCK PRODUCED BY HYPERVELOCITY IMPACT & LATE-STAGE EQUIVALENCE**
P. C. Chou, H. S. Sidhu, and L. J. Zajac Oct. 1964 89 p refs Presented at the 7th Hypervelocity Impact Symp., Tampa, Fla., 17 Nov. 1964
(Contract DA-36-034-ORD-3672-RD)
(DIT-125-6; AD-449930)

The attenuation of strong plane shocks produced by hypervelocity impact is studied. Analytical equations are developed that describe the path of the shock front. Since the entropy change across the decaying shock is included in the derivation, these equations are applicable to both weak and strong shocks. The same problem is also solved graphically by a stepwise characteristic method. The comparison of the graphical and analytical results shows that the simplifying assumptions made for the analytical solution are valid. Calculations using the analytical equations show that late-stage equivalence exists in one-dimensional like-material impacts. Two impacts are equivalent if the quantity $du^{\alpha}\rho$ is the same for both cases. Here, $\alpha$ is between 1 and 2, and therefore, the basis of equivalence is between equal energy and equal momentum. Author

N65-13329# Massachusetts Inst. of Tech., Cambridge.
**STRESS: A PROBLEM-ORIENTED LANGUAGE FOR STRUCTURAL ENGINEERING**
John M. Biggs and Robert D. Logcher 6 May 1964 24 p refs
(MAC-TR-6)

A general purpose programing system for the analysis of structures is described. Compared to other structural programs it has three distinguishing characteristics: (1) The input language is that of the structural engineer, which makes possible direct communication between the engineer and the machine. (2) The system is capable of analyzing a wide variety of structural types and loading conditions thus permitting industrial use on a routine basis. (3) The design process is expedited by the fact that modifications of the original structure for alternate designs can be easily executed. This last capability is most effective when STRESS is used in the time-sharing mode. These features combine to provide a system that not only reduces the effort required for structural analysis but, more significantly, enhances the designer's ability to evolve an efficient structure. Author

N65-13330# Air Force Systems Command, Wright-Patterson AFB, Ohio. AF Flight Dynamics Lab.
**FATIGUE TEST PROGRAM F-104G/MAP AIRCRAFT**
Frank D. Boensch Aug. 1964 22 p
(FDL-TDR-64-97; AD-607208)

The test spectrum of the F104G/MAP airframe consisted of five symmetrical test loadings and one lateral gust loading. The repeated application of these loadings simulated 16 000 hours of service life. At the conclusions of the original test spectrum, a modified spectrum was applied for one additional test lifetime (4000 hours). Finally 100 percent limit load cycles of the original test conditions were run on the article until a catastrophic failure occurred. Based on the fatigue spectrum utilized, the F104G/MAP aircraft has a satisfactory fatigue life. Author

# 33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

**N65-12426#** Los Alamos Scientific Lab., N. Mex.
**ULTRA HIGH TEMPERATURE REACTOR EXPERIMENT CORE HEAT-TRANSFER CALCULATIONS**
Donald W. Mc Eachern 26 Oct. 1964 33 p refs
(Contract W-7405-ENG-36)
(LA-3136-MS)

Two computer codes have been used to calculate the temperature distribution in the UHTREX core. In one code, both heat transfer and coolant-flow distribution between the fuel-element hole and the eccentric annulus for a single, isolated fuel channel are considered. The other code simultaneously calculates the temperature distribution in a seven-channel vertical wedge of the core with a given flow and power distribution. Both programs use a finite-difference technique to represent the conservation of energy equation and the Gauss–Seidel method for solving the simultaneous equations resulting from the implicit finite-difference representation. Temperature profiles calculated using these two codes are presented and compared. Author

**N65-12463#** Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.
**HEAT TRANSFER AND FLUID FLOW INSIDE A HORIZONTAL TUBE EVAPORATOR, PHASE I**
S. William Gouse, Jr. and Karl G. Coumou Jun. 1964 86 p refs
(Grant RP-46)
(DSR-9649-1)

The object of this program was to conduct, at approximately atmospheric pressure, a visual and quantitative study of two-phase one-component flow in a horizontal tube evaporator under conditions of subcooled and bulk boiling over a range of uniform heat fluxes and test fluid-flow rates. In addition to the measurement of all inlet conditions and the temperature, pressure, and heat-flux distributions, high-speed photographs were taken of each final type run in order to permit an accurate interpretation of the data. The experimental results are as follows: (1) Bubbles originating at the wall in the subcooled boiling region do not collapse but continue to grow as they move downstream. (2) The flow becomes annular soon after the bulk of the fluid becomes saturated. (3) The bulk of the fluid is superheated several degrees in the bulk boiling region. (4) Nucleation at discrete points does not contribute to the heat transfer once an annular flow is established. Author

**N65-12503*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**EXPERIMENTAL INVESTIGATION OF INSULATING REFRACTORY-METAL HEAT-SHIELD PANELS**
Gregory R. Wichorek and Bland A. Stein Washington, NASA, Dec. 1964 57 p refs
(NASA-TN-D-1861) OTS Prices: HC $3.00/MF $0.50

The results of an experimental study to determine the capabilities and limitations of a thermal protection system utilizing thin-gage, refractory-metal shields are presented. Cyclic radiant-heating tests to 2400° F were performed on a heat-shield panel having molybdenum-alloy shields coated with a silicide-base coating; a radiographic technique was used to detect oxidation damage and brittle cracking of the coated shields. A heat-shield panel with columbium-alloy shields was subjected to supersonic flow conditions at Mach 3 and at dynamic pressure of 1500 lb/ft$^2$. The results of preliminary tests on a prototype panel with nickel-alloy shields subjected to radiant-heating and wind-tunnel conditions are also reported. Evaluation tests on the molybdenum-alloy shield material were made at temperatures ranging from room temperature to 2900° F. Author

**N65-12559#** Aerospace Corp., El Segundo, Calif. Laboratory Operations
**NONEQUILIBRIUM ROCKET NOZZLE RECOMBINATION LOSSES**
E. A. Cook and L. Schieler 15 Oct. 1964 33 p refs
(Contract AF 04(695)-469)
(SSD-TDR-64-183; TDR-469(9210-02)-1; AD-452236)

Nonequilibrium performance losses are interpreted in terms of radical concentrations and extent of recombination throughout the expansion process. A brief description is given of the Bray method for determining the location of departure from equilibrium flow in a rocket nozzle. The analysis is applied to $N_2O_4$-aerozine, $H_2$-$O_2$ and $H_2$-$F_2$ propellants, and a hypothetical $H_2$-$Cl_2$ system to obtain the point of effective freezing as a function of area ratio. The kinetic rates for the reactions occurring in the combustion process are discussed, and the values for the rates are included. Author

**N65-12620*#** AVCO-Everett Research Lab., Everett, Mass.
**HEAT TRANSFER MEASUREMENTS IN PARTIALLY IONIZED GASES Research Report No. 196**
R. H. Rose and J. O. Stankevics Oct. 1964 49 p refs
(Contract NASw-748)
(NASA-CR-59768) OTS Prices: HC $2.00/MF $0.50

A new technique of making heat-transfer measurements considers the effect of the surface material of the heat-transfer gage. An infrared heat-transfer gage has been adapted to the problems peculiar to this experiment. An analysis is presented that demonstrates the response required of the measurement in order to enable accurate heat-transfer measurements to be made within the limited test times available. The difficulties of adapting the gage to the requirements are described, in particular the sensitivity, opacity, and adherence of the gage to the MgO window. The calibration of the absolute magnitude of the output of the infrared cell, as well as the response time of the measuring system, is described in detail. The response of the gage to the heat transfer encountered in both the shock-tube end wall and on a model are discussed, with emphasis on the identification of radiative heat-transfer effects. Author

**N65-12658#** General Electric Co., Philadelphia, Pa. Re-Entry Systems Dept.
**NOSE SHAPE CHANGE FOR BALLISTIC AND MANEUVERING VEHICLES**
M. J. Brunner 20 Dec. 1964 38 p refs
(TIS-64SD293)

The nose erosion during reentry is investigated for typical high-performance reentry-vehicle applications, including angle-of-attack. Based on both flight and ground test results, the eroded nose shape is determined as a function of the vehicle geometry, material properties, and trajectory. Author

**N65-12698*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**EXPERIMENTAL INVESTIGATION OF THE FEASIBILITY OF ABLATION-COOLING A ROCKET NOZZLE WITH POSSIBLE APPLICATION TO SOLID-PROPELLANT ENGINES**

Richard R. Cullom Washington, NASA, Mar. 1961 41 p refs (NASA-TM-X-418) OTS Prices: HC $2.00/MF $0.50
(Declassified)

Ablation rates of rocket chamber-nozzle inserts made of nylon, polymethylmethacrylate, polyester-fiberglass, and phenolic-silica materials were determined with JP-4, liquid-oxygen combustion. The effect of nozzle ablation on rocket engine performance was also observed. Heat-transfer data from other experiments permitted estimates of the average experimental effective heats of ablation at the nozzle throat; these values were approximately 1900 Btu/lb for nylon, 900 Btu/lb for polymethylmethacrylate, 1000 Btu/lb for polyester fiberglass, and 5000 Btu/lb for phenolic silica. The thermal effectiveness of the ablation materials was reduced by the high shear flow conditions at the nozzle throat. Consequently, calculations show that engine burning times are limited by the rate of nozzle erosion. Author

**N65-12699*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**AFTERBODY HEATING DATA OBTAINED FROM AN ATLAS-BOOSTED MERCURY CONFIGURATION IN A FREE BODY REENTRY**
Emily W. Stephens Washington, NASA, Aug. 1961 51 p refs (NASA-TM-X-493) OTS Prices: HC $3.00/MF $0.50
(Declassified)

An Atlas-boosted capsule was flight tested in an effort to substantiate design information for the Project Mercury capsule, as well as for reentry bodies in general. This report summarizes the afterbody heating data determined from measurements made on the capsule during atmospheric reentry at near-satellite velocities. Detailed examination of the recovered capsule revealed little thermal damage on the conical afterbody, although indication of skin buckling due to excessive heating was clearly visible on the cylindrical section. Measured temperatures showed that peak heating occurred on the cylindrical section where a maximum temperature of 2260° F was recorded and a peak heating rate of 27.5 Btu/ft$^2$-sec was encountered. The jet control system, which was intended to orient and control the capsule attitude, was inoperable during reentry because of a delayed capsule-booster separation. As a result, the capsule reentered the atmosphere at a high angle-of-attack as an oscillatory free body. Author

**N65-12707*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**SOME DESIGN AND OPERATIONAL CONSIDERATIONS OF A LIQUID-HYDROGEN FUEL AND HEAT-SINK SYSTEM FOR TURBOJET-ENGINE TESTS**
Lester C. Corrington, Kenneth L. Thornbury, and Glen Hennings Washington, NACA, 18 Dec. 1956 35 p refs (NACA-RM-E56J18a) OTS Prices: HC $2.00/MF $0.50
(Declassified)

An experimental investigation was conducted in which liquid hydrogen was used as a heat sink for turbine cooling in a high-temperature turbojet engine. A production-model turbojet engine was modified by the installation of a cooled-turbine rotor and stator, and was operated on hydrogen maintained in the supply tank as a liquid. The turbine cooling air was refrigerated by the cold hydrogen as it passed through a heat exchanger. Cooling-air temperatures of 160° to 220° R were obtained at the exit of the heat exchanger with cooling-air flow rates of 3 to 14 percent of the engine airflow. A pressure-surging condition in the fuel system was apparently caused by the vaporization process in the counter-flow-type air-fuel heat exchanger. Liquefaction air in the heat exchanger necessitated a redesign of the airflow passages to provide for a re-evaporation of the liquid by the incoming air. A fire at the hydrogen-tank vent outlet was apparently ignited by a static discharge or a frictional spark from the supporting cables, emphasizing the fact that great care must be used to prevent any undesired exposure of hydrogen to air. Information on the properties of hydrogen is summarized as an aid in the design of systems to handle this fuel in the liquid or gaseous state. Author

**N65-12708*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**BRIEF STUDIES OF TURBOJET COMBUSTOR AND FUEL-SYSTEM OPERATION WITH HYDROGEN FUEL AT −400° F**
David M. Straight, Arthur L. Smith, and Harold H. Christenson Washington, NASA, 7 Mar. 1957 42 p refs (NACA-RM-E56K27a) OTS Prices: HC $2.00/MF $0.50
(Declassified)

A single J-33 combustor and an experimental tubular combustor incorporating a fuel vaporizer were operated with gaseous hydrogen at temperatures slightly above the boiling point of the fuel. Data were obtained to explore possible effects of the fuel temperature on combustor performance and on the control and measurement of fuel flow. Combustion efficiencies and combustor outlet temperature profiles were determined over a range of combustor inlet-air pressures from 4 to 40 inches of mercury absolute and at a combustor inlet-air temperature of 300° F. For comparison, similar data were obtained with hydrogen fuel at ambient temperatures. In general, combustion efficiency was near 100 percent for both combustors and for both the cold and the warm fuels. Combustor outlet temperature profiles were similar to those obtained with liquid hydrocarbon fuels in the J-33 combustor and were not affected by the temperature of the fuel. The vaporizing combustor produced an outlet temperature profile with a hot core. Author

**N65-12775#** IIT Research Inst., Chicago, Ill.
**STUDY OF HEAT TRANSFER THROUGH THERMALLY DECOMPOSING LINER MATERIALS Final Report, Jun. 1963–Jun. 1964**
Arthur N. Takata and W. Wulff Jun. 1964 129 p refs
(Contract DA-49-146-XZ-210)
(DASA-1554; AD-449843)

Experimental studies were made to determine the parameters that affect the heat transfer through materials under transient conditions in which the materials may be decomposing. Six materials were considered: Fiberglas, Fortisan, Lexan, neoprene, sponge rubber, polyethylene, and polyurethane. The following properties were determined: (1) thermal conductivity as a function of temperature; (2) enthalpy of material as a function of temperature; (3) enthalpy of gas evolved by the decomposition as a function of temperature; (4) heat of reaction; (5) weight loss of sample as a function of time, with temperature held constant; and (6) thickness of sample as a function of temperature under long exposure. From this information, a computer program was prepared. The computer program predicted the sample temperatures, the gas flow evolved from the material, and the sample masses and thicknesses at the end of the test. Predictions were generally in good agreement with experimental data and observations. Author

**N65-12804*#** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**HEAT-TRANSFER MEASUREMENTS IN REGIONS OF FLOW SEPARATION AND REATTACHMENT ON TWO AXISYMMETRIC MODELS AT MACH NUMBERS FROM 2.65 TO 4.50**

Robert L. Stallings, Jr., Ward F. Hodge, and Paige B. Burbank Washington, NASA, Oct. 1961 37 p refs
(NASA-TM-X-596) OTS Prices: HC $2.00/MF $0.50
(Declassified)

Heat-transfer coefficients on two axisymmetric models with downstream facing steps were determined in a wind tunnel. One model, denoted as the stepped-cylinder model, consists of a truncated conical nose with a base radius larger than the cylindrical afterbody. The second model duplicates the downstream facing step at the juncture of the fourth and fifth stages of a NASA five-stage research vehicle. The stepped-cylinder model with artificial transition was tested at Mach 2.65 and 3.51, Reynolds numbers per foot from $0.8 \times 10^6$ to $3.1 \times 10^6$, and angles-of-attack from 0° to 20°. At all angles-of-attack, the heating rates on the nose-in and downstream of the region of reattachment were predicted by turbulent cone theory based on the local Mach number and the local Reynolds number using a distance measured from the stagnation point on the front face. Author

**N65-12839*#** United Aircraft Corp., East Hartford, Conn. Research Labs.
**INVESTIGATION OF NONEQUILIBRIUM FLOW EFFECTS IN HIGH EXPANSION RATIO NOZZLES**
V. J. Sarli, W. G. Burwell, and T. F. Zupnik 3 Dec. 1964 91 p refs
(Contract NAS3-2572)
(NASA-CR-54221; UACRL-C910096-13) OTS Prices: HC $3.00/MF $0.75

These investigations were directed toward determining the role that reaction kinetics, contour geometry, and nozzle scale play in influencing rocket nozzle performance. Studies were carried out to establish the applicability of the Bray sudden-freezing criterion for predicting nonequilibrium nozzle performance. Results indicate that the nonequilibrium performance for the selected propellant systems, $H_2$-$O_2$ and $N_2O_4$–50% $N_2H_4$/50% UDMH, is particularly sensitive to the kinetic recombination rate for the three-body water recombination reaction, $H + OH + M \rightleftarrows H_2O + M$. Because of this sensitivity, the single-reaction Bray sudden-freezing criterion is adequate for predicting the nonequilibrium performance of these two propellant systems. Additional results obtained indicate that increasing the nozzle scale (thrust level) can reduce the nonequilibrium specific impulse loss associated with the above propellants. The relative magnitude of the performance change is dependent upon the rocket chamber pressure level. The effects of variations in nozzle contour on performance are not significant for the propellants and operating conditions selected. Author

**N65-12899#** Pratt and Whitney Aircraft, West Palm Beach, Fla.
**TWO-DIMENSIONAL HEAT FLUX MEASUREMENTS IN UNCOOLED ROCKET NOZZLES**
M. R. Glickstein and J. E. Jackson 10 Nov. 1964 34 p refs
(PWA-FR-1187)

Current methods of measuring convective film coefficients and heat fluxes in rocket nozzles are briefly reviewed, and a new method that promises to overcome some of the major difficulties of these methods is presented. The technique presented involves temperature measurements at a point remote from a heated surface, and the relationship of this data to the heat-transfer rate at the surface. The heat-transfer rates in rocket nozzles burning oxygen–hydrogen, oxygen–methane, and oxygen–propane over a wide range of pressures have been measured using the described technique. The results are presented and compared with existing theory. Author

**N65-12900#** Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
**THEORY OF FREEZING**
B. Jancovici Nov. 1964 22 p refs Submitted for Publication
(TH-70)

An approximate theory of freezing is established, starting from the principles of statistical mechanics. A solid is distinguished from a fluid by the behavior, periodic or uniform, of the density of a particle. A generalization of the theory of the molecular field permits writing an exact integral equation for the density of a particle, which interposes nevertheless a correlation function. It is assumed that this last follows an approximate integral equation of the type of the Percus–Yevick equation for the simple model of a gas on a network with infinitely repulsive interactions between nearest neighbors. The theory predicts a phase transition of the fluid–solid type at a density of 0.183. The equation of state is also given in the form of a curve. Trans. by D.E.W.

**N65-12923#** Sheffield U. (Gt. Brit.)
**INTENTIONAL COMBUSTION OSCILLATIONS IN PROPULSION SYSTEMS**
J. Swithenbank and D. Harris [1964] 64 p refs
(Grant AF-EOAR-63-101)
(AD-607334)

The generation of MHD power using the high ionization obtained in combustion oscillations is being investigated. If the detonation wave is a traveling tangential mode, theoretical studies suggest that either strong isentropic waves or cyclic detonation waves may be formed. Calculations of MHD power generation by such waves indicate that power output is a function of particle velocity and is independent of wave velocity. The current and voltage output of isentropic waves calculated as a function of wave amplitude gives a power density comparable with a conventional generator. The magnetic Reynolds number is $<< 1$ so there will be no significant distortion of the applied magnetic field. Increasing the wave strength to a cyclic detonation requires a vortex to confine the wave; the electrical power density of a detonation generator is higher than that of an isentropic wave generator. An experimental apparatus that has been built to verify these theoretical results is described. M.P.G.

**N65-12926#** Ohio State U. Research Foundation, Columbus.
**EXPLORATORY INVESTIGATION OF LAMINAR BOUNDARY LAYER HEAT TRANSFER CHARACTERISTICS OF GAS LIQUID-SPRAY SYSTEMS**
A. N. Tifford Wright-Patterson AFB, Ohio, ARL, Sep. 1964 23 p refs
(Contract AF 33(616)-6503)
(ARL-64-136; AD-608608)

On the basis of an assumed two-dimensional model for the two-phase boundary layer on a body exposed to a gas stream containing liquid drops, an approximate analysis is made of the surface effects occurring with laminar flow. Some of the findings are as follows: (1) Surface rates of heat transfer in an airstream may be increased more than thirtyfold by water drop injection. (2) The surface friction and heat transfer rate always decrease initially with increasing liquid "catch" rates. (3) When the impinging drops have retained at least a little of the local free-stream tangential velocity and/or temperature level, minima and maxima occur in the surface friction and/or heat transfer rate, respectively, as the liquid "catch" rate increases. Author

**N65-13000#** ARO, Inc., Arnold Air Force Station, Tenn. Rocket Test Facility

**THE EFFECT OF NON-EQUILIBRIUM FREE-RADICAL CONCENTRATION ON IGNITION DELAY IN THE HYDROGEN-AIR SYSTEM**

R. P. Rhodes Arnold Eng. Develop. Center, Nov. 1964 14 p refs

(Contract AF 40(600)-1000)

(AEDC-TDR-64-241; AD-608566)

This report presents a theoretical discussion of the effect of nonequilibrium quantities of free radicals on the ignition delay in the hydrogen–air system. A correlation was found between the ignition delay computed from complete reaction kinetics and the initial rate of the reaction $O_2 + H = OH + O$. A rate equation is derived in which a modified expression for the total free radical content is substituted for the H concentration. The implications of nonequilibrium amounts of free radicals on the testing and operation of high-velocity combustion systems are discussed. Author

**N65-13016#** Army Missile Command, Huntsville, Ala. Redstone Scientific Information Center

**STUDIES ON CONTACT HEAT EXCHANGE BETWEEN HEAT ENGINE PARTS**

I. T. Shvets, E. F. Dyban, and N. M. Kondak 3 Nov. 1964 44 p refs Transl. into ENGLISH from Tr. Inst. Teploenerg., Akad. Nauk Ukr. SSR, no. 12, 1955 p 21–53

(RSIC-322; AD-608537)

The temperature fields of several samples of iron sheets, red copper, technical copper, and some admixtures that underwent high compression testing were studied experimentally and analytically. Experiments were performed for the determination of (1) quantitative characteristics of the contact heat exchange; (2) the physical nature of the phenomena that take place during these experiments; and (3) the variation in the amount of thermal resistance of the contact. An analysis of the gathered data shows that the thermal resistance of the contact is related to the finish of the surface, the compression force, and the properties of the material. The thermal resistance of the contacting couple is approximately equal to the arithmetical mean of values for the corresponding similar couples. The heat flow in the contact zone is transmitted basically through the gas layer, and it is assumed that the heat transmission factor varies in direct proportion to the ratio of the heat conductivity factor. The deformation of the microbumps was reversible, notwithstanding the fact that the yield point was exceeded. G.G.

**N65-13017#** Air Force Systems Command, Wright-Patterson AFB, Ohio. AF Materials Lab.

**THERMAL STABILITY OF FLEXIBLE FIBROUS MATERIALS**

Jack H. Ross and C. O. Little Oct. 1964 31 p refs

(RTD-TDR-63-4031; AD-608357)

The continuing need for new thermally stable fibrous materials for the protection of aircrew decelerators prompted an investigation to develop a laboratory technique for simulating the heat and airflow encountered in aircraft fires. With the device available, a number of fibrous materials in single and multiple layers were characterized for thermal stability in the environment simulating that encountered during emergency escape from burning aircraft. This environment involved exposure to 1200° or 1400° F for 10 seconds at an air flow of 225 ft/min. Materials evaluated were primarily HT-1 in various weaves and thicknesses, as well as an HT-1 paper and nylon, dacron, asbestos, and carbon fabrics. The results indicated that a double layer of HT-1 fabric (7.25 oz/yd$^2$) was found to provide superior resistance to heat transfer during the 10-second exposure. Triple layer materials provided no additional thermal protection based on the weight of the structures evaluated. Author

**N65-13062#** Rocketdyne, Canoga Park, Calif.

**A STUDY OF HEAT TRANSFER CHARACTERISTICS OF HOT GAS IGNITION Second Quarterly Progress Report, Period Ending 31 Oct. 1964**

L. W. Carlson and J. D. Seader 6 Nov. 1964 48 p refs

(Contract AF 04(611)-9884)

(RM-1094/362; AD-608389)

Major effort was directed towards the completion of the experimental apparatus and the initiation of experimental tests. Hot gas heater fabrication and assembly was completed. The 2-in.-diam steady-state test section was fabricated, instrumented, and installed. The operation of the system was successfully checked out during both cold and hot gas flow tests. Analytical studies were conducted to develop a suitable gas dynamic and heat transfer model to aid in data correlation. The nature of the initial jet expansion was examined in detail, and available expressions for the fully-developed-flow heat-transfer coefficient were compared. Author

**N65-13192#** Lund U. (Sweden). Thermochemistry Lab.

**THERMAL STABILITY OF ORGANIC COMPOUNDS**

Stig Sunner 15 Apr. 1964 21 p refs

(Grant AF-EOAR-62-110)

(AFOSR-64-1447; AD-604474)

A static pyrolysis apparatus was developed and partly assembled. A shield to be used in adiabatic systems has been constructed, consisting entirely of a wall of microconductors, serving as heater and, if necessary, as resistance thermometer. Author

**N65-13277*#** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

**THE EFFECTS OF INJECTION MASS FLUX DISTRIBUTIONS AND RESONANT COMBUSTION ON LOCAL HEAT TRANSFER IN A LIQUID-PROPELLANT ROCKET ENGINE**

Jack H. Rupe and George I. Jaivin 1 Oct. 1964 28 p refs

(Contract NAS7-100)

(NASA-CR-59902; JPL-TR-32-648) OTS Prices: HC $2.00/MF $0.50

Local values of the heat-transfer rates in a particular liquid-propellant rocket engine–injector configuration are presented. It is shown that during stable, relatively quiescent combustion, the local heat-transfer rates in the chamber vary axially over a range of 0.5 to 4.0 Btu/in$^2$ sec, and circumferentially, at a station somewhat upstream from the nozzle entrance, over a range from 0.5 to 6.0 Btu/in$^2$ sec. Both heat-transfer gradients can be as high as 5.0 Btu/in$^2$ sec/in., and the distribution is extremely sensitive to small changes in injection properties, i.e., gross mixture ratio, with the consequent changes in mass and mixture ratio distribution near the wall. Initial attempts to correlate these data with the injection scheme, as characterized by the properties of nonreactive sprays, indicate that the boundary flow and, therefore, the heat-transfer rate are dominated by the proximity of the propellant to the wall. The local heat-flux distribution attained during resonant combustion is presented, and is compared with values for stable combustion. Author

**N65-13288#** Bureau of Mines, Pittsburgh, Pa.

**FIRE AND EXPLOSION HAZARDS OF FLIGHT VEHICLE COMBUSTIBLES Quarterly Progress Report, Jul. 1–Sep. 30, 1964**

E. L. Litchfield and H. E. Perlee [1964] 13 p refs
(DO-33(615)-64-1007)
(QPR-3; AD-450081)

Suppression of cryogenic propellant explosions and the flammability of halogenated hydrocarbons at elevated temperatures were investigated. The LOX–butane projectile initiation shows a 50-percent probability for a projectile velocity of 365 ft/sec, and the initial shock pressure for LOX–butane is essentially the same as for $LH_2$–$O_2$ but it produces much less projectile velocity than the $LH_2$–$O_2$ system. Deflagration initiation of LOX–butane mixtures shows a strong tendency to undergo deflagration-to-detonation transitions. NaCl does not influence the initiation or propagation of gas-phase detonations. No evidence of instability of the deflagration waves in gaseous hydrogen–oxygen mixtures contained in 6-foot-diameter rubber balloons was detected. The limits of flammability of four halogenated hydrocarbons in air, in oxygen, and in nitrogen tetroxide were determined. All four halogenated hydrocarbons produced flammable mixtures with oxygen at 212° or 302° F; none was flammable with air; and only 1-bromo-2,4-di-chloro-1,1,2,3,3,4-hexafluorobutane was flammable with nitrogen tetroxide. G.G.

**N65-13305#** Stanford U., Calif. Thermosciences Div.
**ON THE SIGNS OF ONSAGER'S RECIPROCITY RELATIONS IN IRREVERSIBLE THERMODYNAMICS**
D. H. Gage and S. J. Kline Mar. 1964 14 p refs
(Contract AF 49(638)-1278)
(IT-1; AFOSR-64-1880; AD-607377) OTS: $1.00

The conventional presentation of Onsager's reciprocity relations specifies that the appropriate flows and forces used in the rate equations for irreversible, coupled processes are obtained from an arbitrary factorization of the entropy production expression. Closer examination shows that arbitrary selection of flows, or dependent quantities, in the rate equations leads to an ambiguity of sign in Onsager's relations. For a system with n independent, coupled, irreversible processes, a proof is given that only two of the possible $2^n$ sets of rate equations obtained by arbitrarily factoring the entropy production expression completely obey $L_{ij} = L_{ji}$. The remaining $2^n - 2$ possible sets of rate equations will have at least one pair of coefficients that will obey the antisymmetric relation $L_{ij} = -L_{ji}$. Author

**N65-13327#** Malaker Labs., Inc., High Bridge, N.J.
**KINETIC STUDY OF ROCKET EXHAUST GASES Quarterly Progress Report, Period Ending 15 Oct. 1964**
[1964] 10 p refs
(Contract DA-30-069-ORD-2918)
(QPR-10; AD-607222)

A photographic photometry method for measuring the radiant energy of propellant flames is described. Using a dual-image device, both bright and dim versions of the same flame image are obtained. Photometric comparisons of radiation intensities are performed by projecting the enlarged photographic image on a silicon photocell and analyzing the readings in accordance with Beer's law. The results are reduced to lumen values by referring to a graph relating log $I_0/I$ and lumens collected by the camera for standard lamp exposures. ($I_0$ = intensity in absence of absorber; I = intensity with absorber present.) The obtained lumen values are then summed over the entire image for all the photographs of each combustion condition. The radiation values obtained on two propellants show a distinct correlation with the plateau observed in burning-rate curves. M.P.G.

**N65-13343#** California U., Berkeley. Space Sciences Lab.
**COMPUTATION OF GASEOUS DETONATION PARAMETERS**
C. W. Busch, A. J. Laderman, and A. K. Oppenheim Aug. 1964 98 p refs
(Contract NAS8-2634; Grant AF-AFOSR-129-64)
(SSL-TN-6; IER-64-12; AD-607380) OTS: $4.00

This report describes the development of a method programed for a digital computer to evaluate one-dimensional detonation parameters in gaseous media. The calculations are based on the assumptions that the mixture is comprised of ideal gas constituents and that the wave process is governed by equilibrium end conditions. Details of the analytical method of solution are presented including the IBM-7090 computer program, described in FORTRAN language. Sample input and output data with instructions for preparing the input data are given. Computations are performed for a number of hydrogen–oxygen mixtures from $H_2 + O_2$ to $3H_2 + O_2$ at several initial conditions covering a range in pressure from 0.1- to 760-mm Hg and in temperatures from −180° to +200° F, and a comparison is made with calculations of other investigators for a stoichiometric mixture initially at NTP. Author

# 34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

**N65-12351#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**INVESTIGATIONS IN THE FIELD OF RADIOTECHNICAL MEASUREMENTS**
15 Sep. 1964 167 p refs Transl. into ENGLISH of the publ. "Issledovaniya v Oblasti Radio Tekhnicheskikh i Zmereniy" Moscow, Gos. Izd. Standartov, 1961 p 1–126
(FTD-MT-64-05; AD-607908)

CONTENTS:

1. SCATTERING OF POWER IN COAXIAL LOAD WITH EXTERNAL CONDUCTOR OF CYLINDRICAL FORM T. L. Zalutskaya and L. Ye. Pecherey p 5–9 refs (See N65-12352 03-10)

2. ERROR OF COAXIAL CALORIMETRIC POWER METER DUE TO INEQUALITY OF THERMAL LOSSES A. V. Grigor'yev, T. L. Zalutskaya, L. E. Pecherey, and A. I. Smirnov p 10–23 refs (See N65-12353 03-14)

3. ERROR OF THERMISTOR BRIDGE VIM-1 DURING MEASUREMENT OF PULSE POWER V. D. Frumkin p 24–35 refs (See N65-12354 03-14)

4. METHOD OF REPRODUCTION OF SMALL VOLTAGES OF HIGH FREQUENCY B. Ye. Rabinovich p 36–45 ref (See N65-12355 03-09)

5. STANDARD METHOD OF REPRODUCTION OF SMALL VOLTAGES OF HIGH FREQUENCY ON SEVERAL HARMONICS B. Ye. Rabinovich p 46–57 (See N65-12356 03-09)

6. INVESTIGATION OF ERRORS OF STANDARD EQUIPMENT FOR REPRODUCTION OF SMALL VOLTAGES AT FREQUENCIES UP TO 1000 Mc G. M. Strizhkov p 58–70 refs (See N65-12357 03-09)

7. ABOUT INCREASE OF ACCURACY OF MEASUREMENT OF ATTENUATION BY METHOD OF SQUARE-LAW DETECTOR Ye. I. Strelkova p 71–78 refs (See N65-12358 03-14)

8. INVESTIGATION OF METHOD OF MEASUREMENT OF ATTENUATION WITH HELP OF SHORT-CIRCUITING PISTON Ye. I. Strelkova p 79–95 refs (See N65-12359 03-09)

9. INVESTIGATION OF FREQUENCY ERRORS OF ATTENUATOR ON WIRE RESISTANCES B. Ye. Rabinovich and O. V. Stoyakin p 96–102 refs (See N65-12360 03-09)

10. INVESTIGATION OF ERRORS OF APPROXIMATE FORMULAS FOR CALCULATION OF DIELECTRIC CONSTANT, BY MEASURED RESONANCE METHOD O. V. Stoyakin p 103–112 refs (See N65-12361 03-26)

11. QUESTION OF MEASUREMENT OF PARAMETERS OF MAGNETODIELECTRICS IN DECIMETRIC WAVE RANGE I. A. Gilinskiy and A. F. Kugavevskiy p 113–119 (See N65-12362 03-26)

12. STANDARD WAVEGUIDE LOADS OF CENTIMETER RANGE L. N. Bryanskiy and Ye. B. Zal'tsman p 120–131 refs (See N65-12363 03-09)

13. COLLATION OF METHODS OF CHECK OF LOOP FIELD-STRENGTH METERS IN FIELD OF INDUCTION AND IN FIELD OF RADIATION V. S. Buzinov p 132–136 refs (See N65-12364 03-14)

14. SPECTRUM OF GENERATOR OF RADIO PULSES WITH STEEP FRONT L. A. Pereverzev p 137–154 refs (See N65-12365 03-09)

15. ERROR OF HARMONIC ANALYSIS OF VOLTAGE, MADE WITH HELP OF MEASURING RECEIVER WITH DIODE MIXER M. M. Levin p 155–163 refs (See N65-12366 03-09)

**N65-12367#** Air Force Systems Command, Wright-Patterson AFB, Ohio Foreign Technology Div.

**AUTOMATIC CONTROL AND COMPUTER TECHNIQUE Selected Articles**

V. V. Solodovnikova 25 Aug. 1964 352 p refs Transl. into ENGLISH of the book "Avtomaticheskoye Upravleniye i Vychislitel'naya Tekhnika" Moscow, Mashgiz, 1958 p 1–304 (FTD-MT-64-270; AD-607889)

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3. ON SELECTING PARAMETERS OF SELF-EXCITED AUTOMATIC CONTROL SYSTEMS Ye. P. Popov p 64-91 refs (See N65-12370 03-10)

4. COMPLETE "FREQUENCY" DESCRIPTION OF RANDOM PROCESSES AND CERTAIN PROBLEMS OF PERFORMANCE OF CONTROL SYSTEMS S. Ya. Rayevskiy p 92–113 refs (See N65-12371 03-10)

5. CERTAIN NEW APPLICATIONS OF THE METHOD OF LOGARITHMIC FREQUENCY CHARACTERISTICS FOR INVESTIGATION OF AUTOMATIC CONTROL SYSTEMS N. T. Kuzovkov p 114–150 refs (See N65-12372 03-10)

6. ELECTRO-HYDRAULIC CONTROLLERS Yu. Ye. Ruzskiy p 151–186 refs (See N65-12373 03-09)

7. INVESTIGATION OF PNEUMATIC AND HYDRAULIC SERVOMECHANISMS V. N. Chelomey p 187–203 refs (See N65-12374 03-03)

8. MAGNETIC AMPLIFIERS FOR SYSTEMS OF AUTOMATIC CONTROL M. A. Rozenblat p 204–231 refs (See N65-12375 03-10)

9. ELECTROMAGNETIC CLUTCHES FOR ACTUATING MECHANISMS P. F. Klubnikin p 232–256 refs (See N65-12376 03-09)

10. MATHEMATICAL BASES OF A DIGITAL DIFFERENTIAL ANALYZER Ye. P. Zhidkov p 257–271 refs (See N65-12377 03-08)

11. DIGITAL INTEGRATING MACHINES F. V. Mayorov p 272–346 refs (See N65-12378 03-08)

**N65-12379#** Advisory Group for Aeronautical Research and Development, Paris (France).

**ARC HEATERS AND MHD ACCELERATORS FOR AERODYNAMIC PURPOSES, PART I**

Sep. 1964 505 p refs Papers presented at the AGARD Specialists Meeting, Rhode-Saint-Genèse, Belgium, 21–23 Sep. 1964

(AGARDograph-84, Pt. I)

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2. APPLICATION OF DISTRIBUTED CHARGE EXCHANGE TO A CROSSED-FIELD ACCELERATOR J. L. Wyatt and W. B. Day (Aerojet-General Nucleonics) p 47–68 ref (See N65-12381 03-25)

3. THEORY OF RAREFACTION WAVES IN A PLASMA G. W. Paxton and R. G. Fowler (Oklahoma U.) p 69–108 refs (See N65-12382 03-25)

4. BLAST WAVE AND CHARACTERISTICS ANALYSIS OF THE FLOW IN AN ELECTROMAGNETIC TEE-TUBE D. C. Dryburgh (Rolls-Royce Ltd., Gt. Brit.) p 109–161 refs (See N65-12383 03-25)

5. FUNDAMENTAL RESEARCH ON THE PLASMAS IN A MAGNETOHYDRODYNAMIC SHOCK TUBE R. M. Head, J. Valensi, and Y. Charvet (Aix-Marseilles U., France) p 163–245 refs (See N65-12384 03-25)

6. TRANSIENT ELECTRICAL CHARACTERISTICS OF INDUCTANCE-DRIVEN ARC DISCHARGES IN HIGH DENSITY NITROGEN R. R. Walker, III and J. D. Whitfield (ARO, Inc.) p 247–276 refs (See N65-12385 03-25)

7. A SURVEY AND PREDICTION OF THE PERFORMANCE CAPABILITY OF COAXIAL ARC HEATERS G. L. Cann and R. D. Buhler (Electro-Optical Systems) p 277–321 refs (See N65-12386 03-25)

8. ARC GAS HEATERS—PRESENT AND FUTURE J. A. Browning and J. W. Poole (Thermal Dynamics Corp.) p 323–351 refs (See N65-12387 03-11)

9. SUMMARY OF SOME OF THE ARC-HEATED HYPERSONIC WIND TUNNEL DEVELOPMENT EFFORT UNDERWAY AT THE LANGLEY RESEARCH CENTER W. B. Boatright, R. B. Stewart, D. I. Sebacher, and M. A. Wallio (NASA, Langley Station, Va.) p 353–377 refs (See N65-12388 03-11)

10. IRREVERSIBLE FLOW IN RESERVOIR AND THROAT SECTIONS OF WIND TUNNELS WITH CONSTRICTED-ARC HEATERS J. L. Potter, G. D. Arney, Jr., W. H. Carden, and M. Kinslow (ARO, Inc.) p 379–412 refs (See N65-12389 03-11)

11. THREE-PHASE A.C. ARC HEATER STUDIES IN THE U.S. NAVAL ORDNANCE LABORATORY E. M. Winkler, R. E. Lee, R. L. Humphrey, and L. J. Milner (Naval Ordnance Lab.) p 413–449 refs (See N65-12390 03-11)

12. EFFECT OF AXIAL FLOW ON THE BEHAVIOR OF THE WALL-CONSTRICTED ARC H. A. Stine, V. R. Watson, and C. E. Shepard (NASA. Moffett Field, Calif.) p 451–485 refs (See N65-12391 03-25)

13. UTILIZATION OF ELECTROMAGNETIC FORCES IN A COAXIAL ARC FOR HIGH VELOCITY AND ENTHALPY RE-ENTRY SIMULATION R. L. Harder and G. L. Cann (Electro-Optical Systems) p 487–513 refs (See N65-12392 03-11)

**N65-12393#** Advisory Group for Aeronautical Research and Development, Paris (France).
**ARC HEATERS AND MHD ACCELERATORS FOR AERODYNAMIC PURPOSES, PART 2**
Sep. 1964 524 p refs Papers presented at the AGARD Specialists Meeting, Rhode-Saint-Genese, Belgium, 21–23 Sep. 1964
(AGARDograph-84, Pt. 2)

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1. RADIATION FROM AN ALTERNATING CURRENT NITROGEN ARC P. W. Schreiber (Aerospace Res. Labs.) p 515–584 refs (See N65-12394 03-25)

2. REAL GAS RADIATION WITH SELF-ABSORPTION AND SPACE VARYING TEMPERATURE C. H. Marston (Gen. Elec. Co.) and T. K. Pugmire (AVCO Corp.) p 585–632 refs (See N65-12395 03-25)

3. THE RADIATING ARC-COLUMN G. L. Marlotte, R. L. Harder, and R. W. Prichard (Electro-Optical Systems, Inc.) p 633–672 refs (See N65-12396 03-25)

4. EFFECTS OF A RADIATIVE HEAT-SINK ON ARC VOLTAGE-CURRENT CHARACTERISTICS W. T. Lord (Royal Aircraft Establishment, Gt. Brit.) p 673–708 refs (See N65-12397 03-25)

5. ANALYSIS OF EXPERIMENTAL RESULTS OBTAINED IN AN ARC USING ARGON J. Fabri (France. Office National d'Etudes et de Recherches Aeronautiques, Chatillon-sous-Bagneux) p 709–726 refs (See N65-12398 03-25)

6. ARC GENERATORS OF WARM GAS F. Charron (France. Office National d'Etudes et de Recherches Aeronautiques, Chatillon-Sous-Bagneux) p 727–750 refs (See N65-12399 03-25)

7. PERFORMANCE CHARACTERISTICS OF A FULLY-DEVELOPED CONSTRICTED TRANSPIRATION-COOLED ARC E. R. G. Eckert and J. E. Anderson (Minnesota U.) p 751–795 refs (See N65-12400 03-25)

8. FUNDAMENTAL CONSIDERATIONS IN ARC HEATER DESIGN R. L. Phillips (Michigan U.) p 797–843 refs (See N65-12401 03-11)

9. GROWTH OF AN ARC COLUMN IN FLOW AND PRESSURE FIELDS H. E. Weber (Gen. Elec. Co.) p 845–881 refs (See N65-12402 03-25)

10. ARC HEATERS PRODUCING FLAT TEMPERATURE DISTRIBUTIONS Th. Peters (Deutsche Versuchsanstalt für Luft- und Raumfahrt, Stuttgart, W. Germany) p 883–902 refs (See N65-12403 03-11)

11. MOTION OF THE PLASMA COLUMN IN THE INTERIOR AND AT THE EXIT OF AN ARC JET G. Kruelle (Deutsche Versuchsanstalt für Luft- und Raumfahrt, Stuttgart, W. Germany) p 903–934 refs (See N65-12404 03-25)

12. SOME OBSERVATIONS OF AN ELECTRIC ARC MAGNETICALLY CONFINED IN A TRANSVERSE SUPERSONIC FLOW C. E. Bond and A. M. Kuethe (Michigan U.) p 935–979 refs (See N65-12405 03-25)

13. DEVELOPMENT AND USE OF AN ION MACH METER TO CALIBRATE AN ARC-HEATED LOW-DENSITY WIND TUNNEL W. A. Clayden (Royal Armament Research and Development Establishment, Gt. Brit.) p 981–1012 refs (See N65-12406 03-14)

14. BOUNDARY LAYER MOTION IN A TWO-DIMENSIONAL ARC-HEATED CHANNEL S. L. Soo and M. N. Bahador (Illinois U.) p 1013–1051 refs (See N65-12407 03-25)

**N65-12569#** Frankford Arsenal, Philadelphia, Pa.
**DEVELOPMENT OF A PAD STAKE EXTRACTOR FOR THE 105 mm XM102 HOWITZER**
Frank T. Pisano Nov. 1964 25 p
(R-1739; AD-451411)

A design was made, and a working model was fabricated. The cartridge and firing mechanism utilized were the standard M30 grenade-launcher cartridge and the 1903 Springfield rifle action. The ballistic tests were divided into two phases, i.e. structural integrity and function. These tests demonstrated that a propellant-actuated device for extraction of large stakes was both feasible and practical. Author

**N65-12976#** Naval Research Lab., Washington, D.C.
**REPORT OF NRL PROGRESS**
William M. Leak, ed. Aug. 1964 49 p refs
(AD-605368) OTS: $1.25

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2. RADAR AURORAL ECHOES S. B. Rutiser p 4–10 refs (See N65-12978 03-13)

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12. SUPPORTING TECHNIQUES H. S. Goulart and H. Rabin p 46

**N65-13248#** Defense Standards Labs., Maribyrnong (Australia).
**ANNUAL REPORT, 1963–1964**
[1964] 51 p

Investigations are reported in chemistry, metallurgy, physics, and in miscellaneous projects such as petroleum microbiology, development of an automatic grenade filling inspection system, and theoretical studies of contact-leaching antifouling paints. R.L.K.

N65-13276*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

**SPACE PROGRAMS SUMMARY NUMBER 37-29, VOLUME IV FOR THE PERIOD AUGUST 1, 1964 TO SEPTEMBER 30, 1964. SUPPORTING RESEARCH AND ADVANCED DEVELOPMENT**

F. M. Sturms, Jr. et al 31 Oct. 1964 350 p refs
(Contract NAS7-100)
(NASA-CR-59900; JPL-SPS-37-29, Vol. IV) OTS Prices: HC $7.00/MF $1.75

Work is reported in systems analysis, program engineering, spacecraft electrical power, guidance and control research, materials research, applied mechanics, computer applications data systems, aerodynamic facilities, solid propellant engineering, polymer research, propulsion research, liquid propulsion, advanced propulsion engineering, lunar and planetary instruments, space instruments, chemistry, fluid physics, physics, applied science, communications elements research, and communications systems research. R.L.K.

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